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Cognitive levels of instruction and student performance in College of Agriculture courses

Miller, Charles, Ph.D.
The Ohio State University, 1989
COGNITIVE LEVELS OF INSTRUCTION AND STUDENT PERFORMANCE IN COLLEGE OF AGRICULTURE COURSES

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of the Ohio State University

By

Charles Miller, B.S., M.S.

* * * * *

The Ohio State University

1989

Dissertation Committee:
L. H. Newcomb
J. R. Warmbrod
J. L. Henderson

Approved by

Advisor
Department of Agricultural Education
DEDICATION

Dedicated to my wife, Monica
and
my parents, Rufus P. and Rose L. Miller
ACKNOWLEDGEMENTS

The author would like to express his sincere appreciation to those individuals who have provided support and guidance throughout his graduate studies.

To Dr. L. H. Newcomb, for his invaluable advise, counsel, guidance, mentorship, and scholarly challenge.

To Dr. J. Robert Warmbrod, for his service on the author’s graduate and reading committees which provided wisdom and insight in the author’s graduate work.

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To the author’s fellow graduate students, and in particular Susie Whittington, Jeff Barcinas and Matt Baker, for their friendship and unique contributions to this work.

To my family, and particularly my wife, Monica, for their love, prayers and support which has carried me through my educational pursuits.
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CHAPTER I
INTRODUCTION

The dynamics of American society have resulted in continued demands for reforms in our nation's educational system. For example, the launch of Sputnik in 1957 resulted in emphasis being placed upon improved science and mathematics education as Americans entered an era of rapid technological advancement. Social concerns of the 1960s and 1970s were reflected in educational reforms which occurred in that era. In the 1980s, the fall of the United States from its undisputed position as the world's leading industrial nation prompted demands that the focus of education be redirected in order to stave off the "rising tide of mediocrity that threatens our very future as a Nation and a people." (National Commission on Excellence in Education, 1983, p. 1).

Many educational reforms being sought presently are in response to a report prepared by the National Commission on Excellence in Education entitled A Nation at Risk. Issued in 1983, this report summarized the work of the Commission in assessing the educational needs of America's society in the 1980s and beyond. One particular area of concern
considered by this commission was that of critical thinking and problem solving ability of students. The Commission heard evidence that many students could not draw inferences from written material and more than 65% of the group studied could not solve multiple-step mathematics problems (pg. 10). This evidence, and similar findings, prompted the Commission to recommend that steps be taken to develop problem solving, critical thinking, and higher level thinking abilities of students at all grade levels (pp. 25, 27).

In order to consider the challenge issued by the National Commission on Excellence in Education, it is necessary to define what is meant by problem solving, critical thinking, and higher level thinking ability. Bloom (Bloom, et.al., 1956, p. 28) labelled these forms of thinking as "intellectual abilities and skills" and operationally defined evidence of these abilities and skills as an individual being able to "find appropriate information and techniques in his previous experience to bring to bear on new problems and situations." Bloom went on to state:

"This requires some analysis or understanding of the new situation; it requires a background of knowledge or methods which can be readily utilized; and it also requires some facility in discerning the appropriate relations between previous experience and the new situation." (p. 38)

Bloom noted that intellectual ability involves the utilization of specific technical information rather than information that is assumed to be "part of the general fund
of knowledge" in order to solve a new problem (pp. 38, 39). Intellectual ability, by this definition, involves more than the mere memorization and recall of facts.

The Taxonomy of Educational Objectives - Cognitive Domain developed by Bloom, Englehart, Furst, Hill and Krathwohl (1956), commonly referred to as Bloom’s Taxonomy, distinguishes between recall of facts and demonstration of intellectual skills and abilities. This taxonomy represents a hierarchy of cognitive levels of educational objectives beginning with knowledge, or recall of facts, and progressing through the various intellectual skills and abilities in the cognitive domain which include comprehension, application, analysis, synthesis and evaluation (Table 1) (Appendix A). Bloom considered these

<table>
<thead>
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<td>Knowledge</td>
<td>remember</td>
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<tr>
<td>Comprehension</td>
<td>translate, interpret, extrapolate</td>
</tr>
<tr>
<td>Application</td>
<td>use abstractions in specific situations</td>
</tr>
<tr>
<td>Analysis</td>
<td>break down concept into components</td>
</tr>
<tr>
<td>Synthesis</td>
<td>use parts or elements to form a whole</td>
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<tr>
<td>Evaluation</td>
<td>judge value of materials or methods</td>
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Bloom et.al., Taxonomy of Educational Objectives, Handbook 1, Cognitive Domain. (1956)
six levels to be cumulative and hierarchical in that advancement to any higher cognitive level required the use of all preceding levels of cognition.

Bloom's definition of intellectual ability, which included the five higher levels of cognitive skills and abilities, does not distinguish between the specifics of problem solving, critical thinking, and higher level thinking. It does however, provide a point of reference for considering the type of thinking abilities being considered. Utilizing this point of reference, the need for student development of these skills may be considered.

Bloom's arguments for fostering the development of student's intellectual abilities were similar to those of the National Commission on Excellence in Education for developing students' critical thinking, problem solving, and higher-order thinking skills. Bloom observed that:

"we find ourselves in a rapidly changing and unpredictable culture, ... we have the task of preparing individuals for problems which cannot be seen in advance, and about all that can be done under such conditions is to help the student acquire generalized intellectual skills and abilities which will serve him in many new situations." (p. 40)

Similar sentiments regarding the need for the development of critical thinking and problem solving skills of students at the postsecondary level have been expressed by individuals concerned with higher education. McKeachie (in Joscelyn, 1988) stated that "everyone agrees that students learn in college, but whether they learn to think
is more controversial" (pg. 1). Lochhead (1979) argued that "We should be teaching students how to think; instead we are primarily teaching them what to think" (pg. 1). Bransford and Vye (1989) also noted that "many traditional approaches to instruction do not help students make the transformation from 'knowing that' something is true to 'knowing how' to think, learn and solve problems" (pg. 193).

Teaching student how to think, or developing their critical thinking and problem solving skills has been identified as a goal of educators in colleges of agriculture as well. Harl (1980) stated that among the abilities which every university graduate in agriculture should possess is "The ability to think and reason - creatively, analytically, thoroughly and with reasonable alacrity" (pg. 5). Poulton (1985) argued that one criteria of quality agricultural education is the development of "critical thinking, to reason logically and apply problem solving techniques appropriately" (pg. 19).

Other university agricultural educators concur with these arguments and have pointed out the need for developing critical thinking and problem solving skills in agriculture students. Kuhn (1977) suggested that "the total mass of knowledge in agriculture to be learned is too great for an individual to learn it all well." Newcomb and Trefz (1987) agreed that knowledge is growing rapidly among the agricultural disciplines. This expanding knowledge base
dictates that teachers in colleges of Agriculture must evaluate the manner in which students are prepared to serve as professional agriculturalists.

Statement of the Problem

A variety of research has been done which considers cognitive aspects of teaching and learning (Pickford, 1988; Newcomb and Trefz, 1987; Fischer and Grant, 1983; Ryan, 1973; Chickering, 1972; Kropp and Stoker, 1966). Studies which focus upon the development of student critical thinking ability, problem solving ability, or higher order thinking skills, particularly at the college level, are limited however. Research in these areas focusing upon colleges of agriculture is extremely limited. In order to broaden the knowledge base in this area, this study considered factors associated with the ability of college of agriculture students to perform at higher levels of cognition as identified by Bloom's Taxonomy.

The purpose of this study was to describe course experiences in The Ohio State University College of Agriculture and the performance of students enrolled in these courses at the various levels of cognition. The study also sought to identify course experiences, student characteristics, and instructor characteristics which are associated with student performance at higher levels of cognition.
Research Questions

Research questions guiding the study were:

1. What was the ability of students to perform at various levels of cognition upon entering selected courses in The Ohio State University College of Agriculture?

2. What was the ability of students to perform at various levels of cognition upon completing selected courses in The Ohio State University College of Agriculture?

3. What were the cognitive levels of instructor discourse, tests and quizzes, and assignments in selected courses in The Ohio State University College of Agriculture?

4. To what extent did relationships exist between cognitive levels of course experiences (instructor discourse, tests, quizzes, assignments) and students' cognitive level of performance?

5. To what extent did relationships exist between additional selected variables and students' cognitive level of performance? Additional variables considered included:
   a. student motivation
   b. student prior experience with course content through work experience, high school courses, and high school activities
c. student academic ability as indicated by ACT composite scores

d. instructor academic preparation, previous course experience and work experience

Limitations of the Study

This study was descriptive in nature and sought to describe variables and identify relationships which existed among selected variables. Such studies cannot establish that cause-and-effect relationships exist among variables (Borg and Gall, 1979).

The study was limited to four Ohio State University College of Agriculture courses being taught by professors agreeing to participate in the project. From a group of 23 candidates, five professors were selected by the researchers and agreed to take part in the study. Following completion of the study, the researchers elected not to include information collected from one of the professor's classes because of extensive missing data and a very small class size (eight students). Consequently, the results of the study are not generalizable to groups beyond those four classes which were analyzed.

A variety of instruments were used to secure information concerning student cognitive performance. Data obtained indicated that the ability of some of these instruments to reliably assess student cognitive performance
was suspect. Instances where such was the case are noted in the instrumentation section of Chapter III as well as in the findings. Results obtained from instruments with questionable reliability require cautious interpretation.

**Need For The Study**

Bloom, in a discussion of educational objectives in the cognitive domain, stressed the need for developing intellectual skills (p. 38). Others have since expressed the need for such skills as well (Harl, 1980; National Commission on Excellence in Education, 1983; Poulton, 1985). Rapid advances in recent years in society, and specific disciplines such as agriculture, have prompted educators to seriously consider means whereby the intellectual development of students may be improved.

Such is the case in The Ohio State University College of Agriculture. Efforts have been underway since 1985 to study, and subsequently improve, the cognitive levels of teaching and learning in this college. Chuatong (1985) carried out the first phase of this research by conducting a preliminary analysis of the cognitive level of assignments and tests used by agriculture professors at The Ohio State University (Pickford, 1988). Newcomb and Trefz (1987) expanded the scope of this study to include sixteen classes within the College of Agriculture and found that only 15% of
all course activities were at the creating or evaluating levels of cognition.

Pickford (1988) sought to identify whether relationships existed between cognitive achievement of students in selected College of Agriculture classes and a number of variables. These variables included cognitive level of instruction, cognitive level of tests and assignments, student previous experience with course content, professor expectations for the course, student cognitive ability prior to entering the course, and interest in and value of the course to the student.

Pickford found that cognitive level of course assignments appeared to have the greatest impact upon student cognitive performance when compared to the other variables considered. There were however, several limitations to this study which suggested that conclusions reached by Pickford required verification. The need existed therefore, to give more detailed consideration to relationships between student cognitive achievement and variables which may be associated with cognitive achievement.

This study included major variables of interest considered by Pickford such as course experiences, student previous experience and instructor previous experience. Additionally, student academic ability and student motivation were considered as possible factors associated
with student cognitive performance. Course experiences (instruction, assignments, tests and quizzes) were selected as the variables which received the most detailed consideration as they appear to be the most common means available to the instructor for changing students' cognitive level of performance.
CHAPTER II
REVIEW OF RELATED LITERATURE

Studies in the area of human cognition as it relates to the processes of teaching and learning have been widespread and varied. Much of the early research in this area can be attributed to Piaget who is considered to be the most important individual among those who have ever studied cognitive development (Meadows, 1983). Years of systematic descriptive research by Piaget resulted in the identification of a number of principles of cognitive development. The most notable of these principles states that "development is a progression from action based, concrete 'operations' or schemas to abstract, systematized, logical operations" (Kurfiss, 1988).

Building upon this premise, a number of scholars in the field of education developed systems for classifying cognitive levels of teaching and learning. In the 1950s and 1960s at least eleven such classification systems were devised (Ryan, 1973). Among these was the Taxonomy of Educational Objectives in the Cognitive Domain developed by Bloom, Engelhart, Furst, Hill and Krathwohl which is commonly referred to as Bloom's Taxonomy. This taxonomy has
since emerged as the most widely used standard which exists for the classification of cognitive behavior in education. Over one million copies of the handbook outlining this taxonomy have been sold, it has been translated into several languages, is used worldwide, and is regularly cited in educational literature (Furst, 1981).

The common use of Bloom's Taxonomy as a means of describing various levels of cognition requires an understanding of this classification system along with its inherent strengths and weaknesses. This chapter will consider these points as well as factors which influence the cognitive levels of teaching and learning included in the Taxonomy.

Bloom's Taxonomy of Educational Objectives

Bloom's Taxonomy was originally developed to establish a common ground for communication between educators involved in testing, curriculum development, and research (Bloom et al., 1956). The taxonomy consists of six levels identified as knowledge, comprehension, application, analysis, synthesis and evaluation. These levels are ordered in a hierarchical fashion, from the most simple (knowledge) to the most complex (evaluation) level of cognitive behavior. Performance at any level of cognition requires progression through all preceding, or more simple, levels of cognition (e.g. knowledge and comprehension is required before
application can be done). A detailed description of each of the levels of cognition in Bloom's Taxonomy is provided in Appendix A.

Research and scholarly writings concerning Bloom's Taxonomy offer evidence that it is largely a valid and reliable means of classifying cognitive behaviors and serves as a valuable tool for educators (Willson, 1983; Furst, 1981). Some of these same studies and writings however, also present valid philosophical and practical concerns regarding Bloom's Taxonomy (Miller, Snowman and O'Hara, 1979; Madaus, Woods and Nuttall, 1973). Others clearly dispute whether the Taxonomy should be used as a means of classifying cognitive behaviors (Schrag, 1989; Ormell, 1974). The following sections will consider the philosophical and practical aspects of Bloom's Taxonomy which these studies have either supported or questioned.

**Philosophical Issues Concerning Bloom’s Taxonomy**

While Bloom's Taxonomy was designed as a purely descriptive means for dealing with the classification of cognitive behavior, a number of philosophical issues concerning the epistemology upon which the Taxonomy is based have been raised (Furst, 1981). Sternberg (1985) pointed out that educational theories such as the one upon which Bloom’s Taxonomy is based "often do not have the clarity in epistemological status characteristic of the philosophical and psychological theories." He supports this contention by
noting that educators are still arguing whether the Taxonomy represents a prescriptive or a descriptive model of human thought.

Furst (1981) addressed this, and other, areas of concern in reviewing and responding to questions of the taxonomy's epistemology. Four primary points of contention considered were the use of behavior-specified goals, distinction between behavioral (process) and substantive (content) objectives, the separation of the cognitive and affective domains, and the cumulative hierarchical structure of the taxonomy.

The use of behavior-specified goals (overt responses) as a means of identifying whether implicit processes (thought) takes place has been questioned by individuals such as Hirst (1974), Ormell (1974), Pring (1971), Sockett (1971) and Willhoyte (1965) (Furst, 1981). Furst agreed that this is a valid concern but indicated that the authors of Bloom's Taxonomy viewed intended student behavior as being implicit behavior. Furst also recognized that use of behavior-specified goals prevents the identification of goals that cannot easily be recognized, such as "understanding." Later citing Broudy (1970) in the Taxonomy's defense however, Furst argued that overt behavioral statements represent the "life uses" of education.
A second major philosophical concern noted by Furst was based upon the failure of the *Taxonomy* to distinguish between "behavioral and substantive (content) elements in statements of educational objectives" (pg. 443). He indicated that the *Taxonomy's* authors considered the advantages of being able to classify objectives across content areas far outweighed benefits gained by developing separate classifications for each content area. Wittgenstein (1953) and his proteges such as Malcolm (1971) and Pitcher (1964) were identified as scholars who object to the use of general categories for the classification of cognitive behavior. Other individuals such as Olson (1976), Ormell (1974), Hirst (1974), Sackett (1971), and Pring (1971) also object to the use of general categories as they consider cognitive processes to be linked to content (Furst, 1981).

A third philosophical concern identified by Furst (1981) is the implied distinction between the cognitive and affective domains of thought. This distinction was viewed as artificial by the authors of Bloom's *Taxonomy* who realized that knowledge and values are not separate.

A fourth concern frequently raised in considering Bloom's *Taxonomy* is the cumulative hierarchical structure of the model. Furst (1981) reported that Phillips and Kelly (1975) considered this structure to be too simplistic for guiding educational theories. Scholars such as Pring
(1971), Orlandi (1971), Purves (1971), and Moore and Kennedy (1971) argue that demonstration of some lower level cognitive behaviors may require mental operations at higher cognitive levels which are not being observed. Research regarding this question has failed to conclusively substantiate or discount this concern (as the following section will illustrate). Consequently, this remains one of the strongest areas of philosophical criticism concerning the Taxonomy (Furst, 1981).

Concerns regarding the hierarchical led Schrag (1989) to conclude:

"(1) We have no way of 'grading' the thinking required by a task in the absence of assumptions concerning the tools and resources the thinker has available for it; (2) the verbal formation of the task provides no basis for identifying the cognitive operations that must be involved in performing it; and (3) we have only crudest means of assessing the relative cognitive demands of tasks in different domains" (pg. 533).

Hirst (1974) felt that the epistemological basis for Bloom’s Taxonomy is inadequate for the task of classifying educational objectives. Sockett (1971) concurred with this conclusion but found the Taxonomy to be an appropriate means for classifying cognitive processes.

Validity of Bloom’s Taxonomy As A Hierarchy

Furst (1981), a co-author of Bloom’s Taxonomy, stated that "of all the properties of the taxonomy, that of cumulative hierarchy seems most central to the theory"
Consideration of the validity of this hierarchical structure is therefore critical in order to determine the validity of the taxonomy as a whole.

A review of research conducted by Willson (1973) found at least six empirical studies which supported the validity of the hierarchy. Among these was a three year comprehensive study conducted by Kropp and Stoker (1966) which involved 1,000 high school students in several subject areas. These researchers concluded that their findings supported the theory of a hierarchical structure. The order devised by Bloom, et al. (1956) was found to be valid with the exception of the evaluation level.

Another noted study of Bloom’s Taxonomy was conducted by Madaus, Woods, and Nuttall (1973). These researchers found direct links between the four lower levels of the taxonomy (knowledge, comprehension, application, and analysis). A weak direct link between the analysis and synthesis levels was also found. The direct link between the top two cognitive levels (synthesis and evaluation), while found to exist, was the weakest of all observed.

Research done by Miller, Snowman, and O’Hara (1979) supported the findings of Madaus, Woods, and Nuttall regarding an extant hierarchy among the first four levels of cognition. These researchers found, however, a split occurring at the application level which resulted in direct links between the application-analysis and application-
synthesis levels. A direct link between the analysis and synthesis levels did not exist as Bloom’s model suggests. The synthesis-evaluation link was found to exist and was hierarchical in this study.

Other empirical studies challenged the notion of a knowledge-comprehension-application-analysis hierarchy. Ormell (1974), in a study conducted in the area of mathematics, concluded that in some cases demonstrating knowledge may require more complex thought processes than demonstrating analysis or evaluation. Madaus, Woods, and Nuttall (1973) found eight strong indirect links (out of a possible ten) between the various levels when the intellectual ability of students was considered in analyzing the results of their study. This finding also led to questions concerning the validity of the hierarchical model.

Consideration of these research results, as well as the philosophical challenges noted earlier, led Furst (1981) to reach the following conclusion concerning the hierarchical validity of the Taxonomy:

"Altogether, these various exceptions suggest that dissecting the cognitive domain into distinct, linearly ordered categories has drawbacks. Inversions occur and there is frequently overlap between and within categories." (pg. 447)

Furst goes on to note, however, that Bloom et al. realized that making clear-cut distinctions would not always be possible when using the Taxonomy.
In spite of the various concerns noted, Bloom's Taxonomy has proven to be a helpful framework for the analysis of teaching and learning (Fain and Bader, 1983). Concerns regarding the Taxonomy's use should be considered in light of the fact that it does not purport to be an all-inclusive, all-purpose tool. It is unlikely that any single scheme might accomplish this (Furst, 1981).

Reliability of Bloom's Taxonomy As An Indicator of Cognitive Behavior

Having considered the validity of Bloom's Taxonomy as a hierarchy, attention should also be given to the reliability of the taxonomy as a consistent indicator of cognitive behavior within and between studies. Reliability concerns focus on the effectiveness of the Taxonomy as a tool for communicating among educators (Pickford, 1988). If the Taxonomy is to serve its intended purpose, it must be capable of providing the consistent categorization of recognized behaviors within and among observers and studies.

A number of studies have reported no significant differences between or among the classifications made by observers in each of the studies (Clegg, Farley, and Curran, 1967; Stoker and Kropp, 1964; Stanley and Bolton, 1957). Davis, Morse, Roberts, and Tinsley (1969) reported a correlation coefficient of .85 when comparing classifications made by observers in their study with those made in previous studies. Fairbrother (1975) also found
consistent classification by observers in studies where observations could be easily categorized.

While Fairbrother and others found consistency in the use of Bloom's *Taxonomy* by observers, they also found that categories are interpreted differently from study to study. Fain and Bader (1983) pointed out that varied interpretations limit the potential for making generalizations about average levels of cognition or the degree to which each of the levels were present in a study. Consequently, interpretation is often restricted to individual studies. Additionally, consideration of several studies simultaneously would be analogous to analyzing a single study which involved many raters. Furst (1983) found that rater agreement decreased as the number of raters increased. Therefore, multiple-study interpretation would be suspect due to poor inter-rater reliability as well.

As one might summarize from the reliability concerns noted thus far, the reliability and communicability of Bloom's *Taxonomy* is closely linked with the training of raters (Pickford, 1988). In the Davis study (1976) cited earlier, training raters was considered crucial in order to ensure an acceptable inter-rater reliability.

While training of raters may be useful in facilitating the appropriate identification of the various levels of cognition by establishing a common standard for use of the *Taxonomy*, training cannot eliminate all reliability
concerns. A final major issue regarding reliability which training may fail to influence is that rater's or observer's ability to accurately assess intended student behaviors. As noted earlier, Bloom et al. (1956) developed their taxonomy with the assumption that intended student behaviors are implicit and that the rater must either know or assume the prior educational experience of those being assessed by the taxonomy. Recommendations to minimize the concern associated with this issue have been offered by Furst and Gall, among others. Furst (1983) recommended that teachers be used to judge the level of test items as teachers have knowledge of the students and the conditions of instruction. Gall (1970) suggested that control of lesson material by the researcher is a means whereby researchers can more accurately determine the level of test questions that they classify.

**Conclusions Concerning the Credibility of Bloom’s Taxonomy**

Despite the existence of valid philosophical and practical concerns regarding the use of Bloom's Taxonomy, it remains one of the most widely used models for analyzing cognitive behaviors. Furst (1981) noted that the Taxonomy, while imperfect, does offer a practical means for organizing the cognitive domain of thought. Gall (1970) stated that the Taxonomy "best represents the commonalities that exist among systems" (pg. 710).
Considering the widespread, effective use of Bloom's Taxonomy and the realization that no model for organizing cognitive behaviors is without flaws, it appears that Bloom's Taxonomy can serve as a solid foundation upon which research can be based.

Cognitive Levels of Teaching and Learning

Inasmuch as Bloom's Taxonomy was designed as a tool for communicating among educators it has found uses in a number of endeavors. Examples of ways in which the Taxonomy has been used include developing goals and curricula, developing student achievement evaluation instruments and evaluating cognitive levels of instruction (Pickford, 1988).

These various uses of the Taxonomy represent efforts to either facilitate the development of intellectual skills and abilities or to understand the process of this development. These goals were considered vital by the developers of the Taxonomy (Bloom et al., 1956). Research to these ends has begun to focus upon the cognitive levels of instruction manifested in teacher oral presentations, examinations, quizzes and out-of-class assignments for example. The following section considers findings from these studies.

Cognitive Level of Instruction

Cognitive development takes place in conjunction with, or some might say in spite of, formal instruction. It is theorized that if instruction does not provide opportunities
for students to attain and master cognitive abilities they will not be proficient at operating across the levels of cognition (Pickford, 1988).

Unfortunately, much of the research that has been done on the cognitive levels of instruction indicates that a preponderance of oral presentations by teachers as well as the textbooks and examinations associated with instruction typically reflect thinking at the lower levels of cognition (knowledge, comprehension, application). In a summary of research involving types of oral questions used, Gall (1970) found that 60% of the questions involved recall of facts, 20% required students to devise an answer which required more than mere recall of facts and 20% were procedural. Davis et al. (1969) found that instructional objectives, textbook questions, classroom tests, other instructional materials and oral presentations by teachers emphasize fact or memory questions. This was found at both the primary and secondary levels.

At the college level, similar results can be found in reviewing the limited research done in this area. Fischer and Grant (1983) found that discourse in college classes is predominantly at the lowest levels of cognition irregardless of the kind of institution, the course level, the subject area or the length of time in session. Newcomb and Trefz (1987), in a study of 16 undergraduate College of Agriculture courses, found that 37% of the learning occurred
at the remembering level (the equivalent of Bloom's Taxonomy knowledge level) and much of the additional learning (44%) occurred at the processing level (the equivalent of Bloom's Taxonomy levels of comprehension, application and analysis). Pickford (1988), also in a study of College of Agriculture undergraduate courses, found 46% of the teaching behaviors demonstrated by instructors in the study were at the knowledge level. Approximately three percent of these individuals' instruction was at the synthesis or evaluation levels.

Test and quizzes reflect the emphasis placed on lower cognitive levels of instruction. Cross and Angelo (1988) summized:

"Many teacher-made measures concentrate on the lower levels of intellectual skills, namely, on measuring students' abilities to remember and reproduce what is presented by others" (pg. 15).

In a review of empirical research on the cognitive level of college examinations, Milton (1982) found that instructors rely largely on text questions to construct examinations and that 95% of all items in the surveyed exams were at the recall level. Newcomb and Trefz (1987) reported that 44% of all test and quiz items examined in their study were at the remembering (knowledge) level and an additional 44% were at the processing (comprehension, application and analysis) level. Pickford (1988) found that the cognitive level of items on examinations and quizzes emphasized performance at
the knowledge, translation and application levels of Bloom's Taxonomy.

Out-of-class assignments have also received limited attention in analyses of the cognitive levels of instruction in higher education. Chickering (1972) reported that "the mental activities used in outside study vary in ways consistent with the mental activities used in class" (pg. 137). Pickford (1988), on the other hand, found that cognitive level of out-of-class assignments varied considerably by instructor, but on the average were higher than the cognitive level of tests and quizzes given in class. Newcomb and Trefz (1987) found that 61% of the out-of-class activities assessed in their study were at the processing level (comprehension, application and analysis levels of Bloom's Taxonomy).

Factors Affecting Students' Level of Cognitive Performance

While it is important to consider the levels of cognition at which teaching and learning are occurring, it is erroneous to assume that such research alone will result in the eventual improvement of cognitive performance by students. There are numerous complex factors which appear to affect student cognitive performance (Pickford, 1988). Researchers have sought to identify these factors and determine their contribution to student cognitive performance. Consideration of these factors, both
individually and collectively, is required in order to develop a true perspective of how students gain proficiency at complex thinking.

Pickford (1988), in reviewing literature concerning student cognitive performance, identified three major groups of factors which impact upon student's cognitive ability. These were teacher behaviors, use of examinations, quizzes and assignments, and student intellect. A further review found support for including student previous experience and motivation as factors which may influence students' cognitive performance. The following sections consider these factors in detail. 

**Teacher-Related Factors**

The role of the teacher is typically viewed as an organizer and provider of information. McKeachie, Pintrich and other cognitive psychologists assume that cognitive performance is dependent, in part, upon the "qualitative organization and structure of knowledge" which is manipulated by the teacher (Pintrich, 1988, pg. 67). One means whereby the manner in which teachers organize and structure knowledge can be determined is through consideration of discourse which occurs in classrooms (Fischer and Grant, 1983).

A number of studies have sought to determine whether the occurrence of higher cognitive levels of discourse in the classroom is associated with student performance at
higher levels of cognition. Hunkins (1968), in a study of sixth grade social studies students, found that teacher questioning at the highest levels of cognition (synthesis and evaluation) did not result in a significant improvement when compared with students who were taught using lower level teacher questions. The same results were found to hold true for written questions as well. In a similar study however, Ladd (1969) found posttest scores to be significantly correlated with the teacher level of inquiry.

Taba (1966), also in a study of elementary social studies students, compared students taught by teachers trained to use Bloom's Taxonomy to guide instruction with students who were taught by teachers with no such training. While the results did not indicate whether the cognitive level of student performance was superior for students whose teacher received training, it was reported that the trained teacher classes had an increase in the number of higher level interactions, produced a greater number of ideas and had ideas or units of thought that were greater in complexity. The trained teachers classes were also generally superior to the untrained teachers classes in ability to discriminate, infer from data, and apply principles to new situations.

Ryan (1974, 1973) also found that relationships between cognitive levels of discourse (in the form of questions) and student achievement in studies involving elementary social
studies students. In the first study (Ryan, 1973), students were divided into three groups. One group was taught using high cognitive level questions, one group was taught using low cognitive level questions, and one group was taught without the use of questions. Results indicated that students taught in both groups using questioning had significantly higher achievement on tests given immediately following the treatment than those students taught without the use of questions. On a later posttest to assess retention, students taught using high cognitive level questions were better able to perform across all of the levels of cognition than those students who were taught using low cognitive level questions.

In a follow-up study, Ryan (1974) sought to determine whether similar results would occur if questioning was used more extensively in both the high cognitive level and low cognitive level question groups. The results indicated that both groups taught using questions significantly outperformed those students taught without the use of questions on the posttest immediately following the treatment and on the retention test.

Results of other studies considering the relationship between cognitive level of questioning and student achievement have differed from those of Taba and Ryan. Rogers and Davis (1970) found that no significant differences in student performance existed between groups of
students taught using higher cognitive level questions and students in a control group. These researchers did qualify their findings however, by noting that the treatment groups were taught by student teachers and only for a relatively short period of time.

Buggey (1972), in a study of second graders, also found no difference in student performance between the two experimental groups in the study. One group was taught using 70% recall and 30% higher cognitive level questions while instruction for the second group consisted of 30% recall and 70% higher cognitive level questions. Both groups, however, had significantly higher achievement than the control group which was taught without the use of questions.

Gall and his colleagues, in a series of studies (Gall and Ward, 1978; Gall et al., 1976; Gall, 1970) also sought to determine the optimum cognitive level of questioning. These researcher found that student achievement was lower when teachers used 50% high cognitive level questions than when they used either 25% or 75% high cognitive level questions. An additional interesting result was that the achievement of students taught using 25% and 75% high cognitive level questions was similar.

Studies such as these which consider the association between cognitive level of discourse and level of student performance in higher education appear to be virtually non-
existent. The single exception found was the Pickford (1988) study of undergraduate College of Agriculture courses. This study found a low correlation ($r = .17$) between cognitive level of teaching and cognitive level of student performance.

The conflicting findings presented raise questions concerning the degree to which teacher discourse affects student cognitive performance. The complexity of this issue is further compounded when one considers that teacher discourse is not the only type of teacher behavior which may impact students.

Scholars such as Smith, McKeachie, and Flanders have considered how teacher behaviors which attempt to elicit active involvement, and student behaviors which are indicative of that involvement, relate to student cognitive performance or critical thinking ability. Both McKeachie (1974) and Flanders (1970) found positive relationships between these variables (more active involvement was associated with students performing at higher levels of cognition or critical thinking).

Smith (1977), in a study of 12 faculty members in a small liberal arts college, found that teacher encouragement was positively related to improved critical thinking. McKeachie (in Joscelyn, 1988) noted this finding and went on to conclude that student gains in thinking skills also result from an explicit emphasis by the teacher on problem
solving procedures and methods using varied examples as well as teacher verbalization of methods and strategies to encourage development of metacognition.

A final point of inquiry considered in the area of teacher behaviors and their association with cognitive level of instruction was pursued by Bane (1969) and Brown (1968). These researchers found significant relationships between the subjects which teacher taught and the levels of cognition at which they taught. Bane concluded that "the number of significant relationships found ... suggest very convincingly that what teachers teach influences to a great extent how they teach" (pg. 65).

Examinations, Quizzes and Assignments

Teachers' behaviors or characteristics do not represent the sole means whereby they may some influence upon students' cognitive performance. Examinations, quizzes and assignments used by the teacher also appear to play a role in influencing student cognitive ability. Bransford (1989), citing a number of cognitive scientists, argued that "new knowledge must be actively constructed by learners" (pg. 188). In order to do this, students must have the opportunity to actively use this new information. Assignments are means whereby this is accomplished. McKeachie (1980) also supported this contention by stating that cognitive development is not solely dependent upon
efforts of the teacher in the classroom. What students do outside of the class is critical.

Unfortunately, as has been the case in earlier instances, there has been limited empirical research which directly considers the relationship between the nature of examinations, quizzes and assignments and student cognitive performance. In the single study identified which considered this issue, Pickford (1988) found a substantial relationship ($r = .67$) between the cognitive level of tests and assignments and students' level of cognitive performance.

**Student-Related Factors**

Irregardless of nature of instruction and its various elements, the levels of cognition which students perform at will invariably rely, to some extent, upon the students themselves. Student intelligence, background, and motivation appear to be factors which may influence the cognitive performance of students.

Studies which have considered relationships between intelligence and performance at various levels of cognition have been conducted by Kropp and Stoker and later by Roberts. Kropp and Stoker (1966) found links between general ability (which included intelligence) and all levels of Bloom's Taxonomy. These links were weak, however, at the synthesis and evaluation levels. Roberts (1974) found that intelligence (as measured by I.Q. scores) was not
significantly related with performance at the higher levels of cognition.

Students' backgrounds may also play a role in determining their ability to perform at various levels of cognition. McKeachie (1980) felt that "background of students in the area is probably more important than the student's level of intelligence" (pg. 28). A 1987 study by Lawrence, however, found that students' prior experience in working with horses had no effect on their performance (final grade) in a horse management course.

One student variable in the Lawrence study (1987) that was found to be positively associated with student performance was level of interest. This finding supports the observation made by McKeachie and Webster more than 25 years earlier that "it is generally realized that cognitive and intellectual aspects of personality are functionally related to affective or motivational states" (McKeachie and Webster, 1960, pg. 324). Pintrich (1988) found that motivation "is always ignored or poorly conceptualized in cognitive models of student's learning, critical thinking, or problem solving" (pg. 74). He goes on to suggest that this omission is inappropriate as initial acquisition of knowledge and transfer of cognitive skills across cognitive domains requires that the learner be motivated (citing McKeachie, Pintrich, Lin, and Smith, 1986).
Considering indicators such as motivation, which represents the students' affective domain of thought, appears appropriate in that the cognitive and affective aspects of thought cannot be separated from either a conceptual or a practical standpoint (Pring, 1971).

Other Factors Affecting Student's Cognitive Performance

A number of factors in addition to those presented thus far have been identified by research as possibly being associated with the demonstration of higher level cognitive behaviors by students. Fischer and Grant (1983) found that higher cognitive levels of student discourse were associated with larger institutions. These researchers also found higher cognitive levels of student discourse associated with small class size. McKeachie and Kulick (1975) also reported that smaller classes, as well as use of discussions rather than lecture and student-centered rather than teacher-centered discussions, were associated with better application, transfer, and problem solving by students.

Gall et al. (1970, 1976, 1978) also found discussion to be an important aspect of developing student's cognitive abilities. These researchers, along with Ryan (1973, 1974) suggest that the sequence and types of questions used in discussions may contribute to cognitive development. This area, as with others noted throughout this review, requires additional focused research in order to assess its role in influencing student cognitive performance.
Summary

Educational research in the area of cognition has largely been based upon a hierarchical classification model developed by Bloom, Engelhart, Furst, Hill, and Krathwohl in 1956. This model, designed as a tool to allow educators to communicate about the cognitive domain of thought on a common basis, has been widely used in the areas of research, curriculum development and test development.

Years of use of Bloom's Taxonomy in varied applications and settings has led to its general acceptance as a valid and reliable means of classifying cognitive behaviors. Valid criticisms from both philosophical and practical standpoints have been made concerning the taxonomy however. Unfortunately, it is questionable whether it is possible to develop a single model which can structure the cognitive domain of thought with little or no philosophical, psychological, or practical flaws. Consequently, the use of Bloom's Taxonomy, keeping in mind its shortcomings, has been deemed appropriate (Furst, 1981).

Studies of the levels of cognitive performance by students using Bloom's Taxonomy have been done largely at the primary and secondary levels. From these studies, it appears that several variables associated with the teacher, the student, the course, and even the institution affect students' cognitive performance. Empirical research which has considered each of these factors is limited however, and
contradictory results have often been found. Consequently, the nature and relative importance of the various factors influencing students' cognitive performance have yet to be conclusively determined.
CHAPTER III
METHODOLOGY

The purpose of this study was to describe course experiences in four Ohio State University College of Agriculture courses and the performance of students enrolled in these courses at the various levels of cognition. The study also investigated relationships between the cognitive levels of student performance and a number of variables. Student cognitive ability was assessed using a standardized instrument as well as examinations developed by the researchers and course instructors while course experiences were analyzed using an instrument based upon Bloom's Taxonomy. Information was also gathered concerning student motivation, student previous experience, and instructor experience.

This chapter will discuss the research design, population and sample, instrumentation, data collection, and data analysis procedures employed.

Research Design

This study was descriptive in nature. A wide variety of data were gathered in order to present a detailed
explanation of each of the variables of interest. This procedure was followed in order to facilitate replication of the study and critical analysis of the results.

The major variables of interest which the study sought to describe included:

- the ability of students to perform at the various levels of cognition upon entering the course;
- the ability of students to perform at the various levels of cognition upon completion of the course;
- the cognitive level of instructor discourse;
- the cognitive level of assignments; and
- the cognitive level of tests and quizzes.

Additional variables considered as possible factors related to the cognitive level of student performance were:

- student motivation;
- student academic ability;
- student prior experience with course content through high school activities or work; and
- instructor academic and work experience.

Demographic information on the students and instructors were also gathered in order to facilitate replication of the study and its comparison to similar research.

Population and Sample

The population for this study was 134 students enrolled in four introductory level courses in the Ohio State
University College of Agriculture during Spring Quarter, 1989. Students enrolled in these courses comprised experimentally accessible intact groups.

The classes included in the study were initially identified as being among the 23 introductory level courses (100 or 200 level courses) being taught in the College of Agriculture during the second quarter of 1989. These courses were categorized into the areas of animal sciences, plant sciences, food sciences, social sciences, and engineering sciences. From each of these areas one class was purposefully chosen on the basis of instructor willingness to participate in the study and knowledge of the instructor's desire to improve his/her teaching performance.

Classes involved in the study included a horticulture class of 44 students, a food science class of 37 students, an agricultural economics class of 25 students, and a dairy science class of 21 students. Data was collected from an agricultural mechanization class of eight students but the class was later eliminated for reasons noted in Chapter I.

Instrumentation and Data Collection

The nature of variables considered required the use of a several different instruments. A discussion of each of these instruments and the procedures followed in its administration follows.
Cognitive Level of Instruction

One of the major variables of interest in the study was the cognitive level of instruction, or more specifically, the cognitive level of instructor discourse. The Florida Taxonomy of Cognitive Behavior (FTCB) (Brown, Ober, Soar and Webb, 1966) was the instrument used to classify cognitive level of instructor discourse. This instrument is based upon Bloom's Taxonomy (Bloom, et al., 1956) and is designed to identify specific cognitive behaviors of teachers or students.

While the development of the FTCB was based upon Bloom's Taxonomy, the two are not identical. The FTCB recognizes seven major levels of cognition rather than six as does Bloom et al. In the FTCB, the areas of Translation and Interpretation encompass Bloom et al.'s level termed Comprehension. The Florida Taxonomy also recognizes three aspects of the knowledge level of cognition, but considers them to be equivalent. The Application, Analysis, Synthesis and Evaluation levels are similar in both taxonomies. Table 2 presents a comparison of the levels of cognition identified in Bloom's Taxonomy and those used in the Florida Taxonomy of Cognitive Behavior.

Within each of the levels of cognition (knowledge, comprehension, application, analysis, synthesis, evaluation), Bloom et al. identified specific types or categories of behavior that are indicative of that level.
The FTCB includes 55 such categories. Approximately one-third of these 55 categories are indicators of the knowledge level of cognition and are classed under the areas of knowledge of specifics, knowledge of ways and means of dealing with specifics, and knowledge of universals and abstracts. The Translation level includes six categories of behavior that indicate the use of knowledge by restating facts in a different form or by giving examples. The Interpretation level also includes six categories. This level focuses upon thought which is indicative of an understanding of relationships (i.e. giving reasons).

Table 2
Comparison of the Cognitive Levels of Teaching and Learning Included in 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>
</tr>
<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>
</tr>
</tbody>
</table>
The remaining three levels of the FTCB are Analysis, Synthesis, and Evaluation. They include eleven, nine, and two categories of behavior respectively and these categories are comparable to those specified by Bloom et al. (1956). Appendix B, which is an example of the actual form used, provides a complete listing of the levels of cognition and specific categories associated with each in the FTCB.

The FTCB and a manual describing its use were developed by Brown, Ober, Soar, and Webb (Simon and Boyer, 1974). This instrument was tested and used in a number of studies including those of Brown (1968), Bane (1969), Brown et al. (1969), Wood (1969), Brown and Bane (1970), and Brown and Webb (1973). The validity of the FTCB is based upon its direct derivation from Bloom's Taxonomy. Consequently, it is argued that the FTCB can be considered valid in light of the support generally given to Bloom's Taxonomy as a means of identifying behaviors in the various levels of cognition.

Reliability of the FTCB is dependent upon the raters' utilization of the instrument. In this study, a single rater was involved in assessment of course experiences using the FTCB. The rater received training from a researcher with extensive experience in the use of the FTCB. Training involved an explanation of the use of the instrument followed by practice using video taped teaching episodes. Initial practice sessions were conducted with the trainer present to provide guidance in the use of the instrument.
Later sessions involved independent practice by this study's rater. Following training, intrarater reliability (a measure of rater consistency in use of the instrument) was assessed by using observations of two video tapes of teaching by Plimpton (1981) and Golden (1981). Spearman correlation coefficients were calculated using the SPSSx-PC+ statistical program. The intrarater reliability was .98 for the Plimpton tape and .99 for the Golden tape. The major researcher served as the rater for all course experiences evaluated using the FTCB.

Use of the FTCB involves the categorization of cognitive behaviors observed during six minute intervals. Each time a behavior was observed it was categorized by marking the appropriate box for the given six minute time period (Appendix B). Each box was marked only once during each six minute period even though the behavior may have been observed several times. For example, if the instructor defined three words during one six minute interval, "defines meaning of a term" was only marked once for that period. Behaviors considered were based upon verbal discourse as well as written information presented through the use of visuals or handouts.

Each class was observed three times during Spring Quarter, 1989. Most observations were made at three week intervals beginning the third week of the quarter. Slight departures were made from this schedule in order to avoid
conducting observations during periods when tests or quizzes were given.

All class observations were audio recorded. While class was in progress the observer noted statements reflecting each six minute transition point and recorded any written information that would not be apparent from a review of the audio tape. A single form was used to record all observation and transition notes (Appendix C). Actual categorization of behaviors by the observer using the FTCB occurred following the class. The audio recordings and notes taken during class provided the evidence of behaviors recorded.

Cognitive Level of Assignments, Tests and Quizzes

One of the original intended uses of Bloom's Taxonomy was the classification of cognitive levels of test items (Bloom et al, 1956). Subsequent studies such as those by Newcomb and Trefz (1987) and Pickford (1988) have demonstrated that use of the Taxonomy to classify test and quiz items, as well as various types of assignments, is feasible and appropriate.

Copies of all tests and quizzes used by instructors as a means of evaluating students were collected. Each test and quiz item was classified by the researcher using the Florida Taxonomy of Cognitive Behavior. Assignments, which included all evaluated work completed outside of class
such as homework exercises, laboratory reports and summaries of research, were also classified using the FTCB.

**Student Cognitive Performance Upon Entering Course**

The ability of students to perform at the various levels of cognition upon entering the courses considered was a major variable of interest in the study. Student cognitive performance was assessed at the beginning of each course using two pretests. General cognitive performance was evaluated using a standardized test entitled the Developing Cognitive Abilities Test while student cognitive ability in each subject matter area was determined using researcher developed pretests. Specifics concerning each of these pretests follow.

**The Developing Cognitive Abilities Test (DCAT).** The Developing Cognitive Abilities Test (hereafter referred to as DCAT) was administered to all students in the study as a common measure of student cognitive performance. The test was designed to indicate cognitive characteristics that can be altered or modified through instruction. It includes three cognitive levels of ability identified as basic cognitive abilities (knowledge and comprehension), application skills (application), and critical thinking skills (analysis, evaluation and synthesis) (Beggs, 1988). The three areas considered in the test are verbal, quantitative, and spatial abilities. Each of these sections is timed and can be considered independently in analyzing
the exam results. Because of time constraints in administering the examination only the verbal and quantitative sections were used in this study.

The Level L form (grade 12 level) was the most advanced version of the instrument available. Inasmuch as this test was not specifically designed for assessment at the beginning college level, ceiling effect was considered a possible validity threat.

On the general cognitive abilities and application skills sections of the DCAT, ceiling effect was noted as a validity concern. The mean percentages correct in both of these sections on the pretest and posttest was approximately 80% with a standard deviation near 14.0. These values indicated that students with perfect scores (100%) ranked at the 90th percentile on these sections of the test. Students averaged 62.5% correct on the critical thinking sections of the pretest and posttest with standard deviations of approximately 18.5. This ranked students with perfect scores on the critical thinking section in the 97th percentile for that section of the test. It was concluded that ceiling effect was less of a validity concern on the critical thinking portion of the DCAT.

Test sensitization was also a possible validity threat considered in using identical forms of the DCAT for the pretest and posttest. Similar means and standard deviations on the pretest and posttest indicated that test
sensitization associated with the DCAT was not a problem in this study however.

Reliability of the DCAT was assessed in this study for the three levels of cognition represented in the instrument. Kuder-Richardson 20 coefficients for these levels were .65 for basic cognitive abilities, .59 for application skills, and .72 for critical thinking skills.

Because the DCAT is a timed test, arrangements were made with the instructors to allow the researchers to administer the examination during the first week of classes. The major researcher and a fellow research associate administered all DCAT pretests at that time according to the Directions for Administration provided with the test.

Beggs (personal communication, 1988) indicated that post-secondary norms on the DCAT were being collected during spring, 1989. These norms were not available prior to the reporting of this study however.

**Subject Specific Pretest.** A subject specific pretest was developed by the researchers for each course based upon examinations and quizzes given in each course previous quarters. These pretests included multiple choice questions at the knowledge, comprehension, application, analysis and evaluation levels of cognition. Synthesis level questions were not included because of the difficulty of preparing synthesis level questions that could be objectively scored.
Validity of each of the subject pretests was assessed from two perspectives, content validity and cognitive level of test items. Content validity was considered by the instructor of the course for which the examination was prepared. All examinations were found to be appropriate with regards to the content and level of questions. A small number of items were found to have no response that was clearly correct and were therefore eliminated from the pretests. The cognitive level of test items was assessed by an individual who had extensive experience in classifying the cognitive levels of examinations, quizzes and assignments using Bloom's Taxonomy. This review indicated that each of the instruments appeared to offer valid assessments of the various level of cognition.

Reliability was considered using the instruments completed in the study. The Kuder-Richardson 20 coefficients found for each of the pretests were .66 for the agricultural economics pretest, .70 for the dairy science pretest, .45 for the horticulture pretest, and .19 for the food science pretest.

The low reliability coefficient obtained for the food science pretest was attributed largely to the smaller number of items included on the pretest (30 versus 50). Fewer items were included on the food science pretest because of researcher difficulty in securing reference materials for developing test items at the higher levels of cognition.
Old examinations provided the researcher included items almost exclusively at the knowledge level of cognition.

The subject matter pretests were administered in class during the first week of classes. Students were allowed approximately fifty minutes, or one class period, to complete the test.

**Student Cognitive Performance Upon Completion of Course**

The course experiences, student characteristics, and instructor characteristics considered in this study theoretically had some impact upon changes in students' cognitive performance during the courses being studied. Two means were used to assess whether changes in student cognitive performance actually occurred. These measures were the course final examination and the Developing Cognitive Abilities Test.

**Course Final Examination**. Items on each course final examination were classified by the researcher using the Florida Taxonomy of Cognitive Behavior. A weighting factor was then assigned to each item based upon its level of cognition. In order to reflect the theory of a cumulative hierarchy existing in cognitive thought processes, items at higher levels of cognition were weighted more heavily than those at lower levels. The greater weight given to items at higher levels indicated mastery at all preceding levels of cognitive thought.
The weighting values used were those devised in earlier cognition studies (Newcomb and Trefz, 1987; Newcomb and Straquadine, 1987) and employed by Pickford (1988) in conducting a similar assessment of the cognitive level of final examinations. It should be noted that the synthesis and evaluation levels were weighted equally as research results have yet to clearly establish the order of these levels (Madaus, Woods, and Nuttall, 1973; Kropp and Stoker, 1966). The value assigned each level of cognition appears in Table 3.

Each final examination item was also weighted according to the proportion of the total grade value assigned the item.

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Value</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>
by the instructor. Weighting each item according to its grade value was done to reflect the emphasis that the instructor placed upon the importance of that item.

The Developing Cognitive Abilities Test. The same DCAT instrument administered at the beginning of the quarter was readministered during the final week of classes in order to determine whether changes in cognitive ability that were not specifically related to the subject matter had occurred. This posttest was administered in class in the same manner and by the same individuals who administered the DCAT pretest.

Student Motivation

Student motivation was assessed using the Motivated Strategies for Learning Questionnaire which is commonly referred to as the MSLQ (Appendix D). This instrument provided an indication of the level of student motivation associated with the courses studied.

The MSLQ was completed by students outside of class during the first week of the quarter. Prior to distribution of the MSLQ, the researchers explained its purpose and encouraged students to complete and return the instrument. Instructors were also asked to encourage students to return the instrument but students were under no mandate to do so.

The MSLQ was recently developed by McKeachie, Pintrich, and colleagues for assessing student motivation associated with the cognitive aspects of teaching and learning
(Joscelyn, 1988). The authors have found the instrument to be a valid measure of student motivation based upon reviews and preliminary test results. Reliability of the instrument has yet to be reported from earlier studies, but a Cronbach’s Alpha coefficient of .85 was calculated for the MSLQ in this study.

It should be noted that the complete MSLQ instrument includes two major sections entitled ‘motivation’ and ‘learning strategies’. While students were asked to complete the entire instrument, only responses given in the ‘motivation’ section of the questionnaire were considered in this study.

Student Academic Ability

ACT composite scores were used as an indicator of student academic ability as they provided a feasible and accessible common measure of this student characteristic. ACT scores were obtained from students’ university academic records.

Student Previous Experience

Student previous experience in the subject matter area was evaluated using a questionnaire developed by Straquadine in 1987. The validity of the instrument was established by a panel of six teacher educators and researchers and a Cronbach’s Alpha of .70 was reported following a pilot test of the instrument (Pickford, 1988).
The items focusing upon student previous experience allowed students to give "yes" or "no" responses to statements concerning their prior experience with the course content at the high school and college levels through classroom instruction, extracurricular activities, or work experience. In this study, these statements were taken directly from the original instrument and included as items 14 a. - 14 j. of the Demographic Information Questionnaire (Appendix E).

The Demographic Information Questionnaire was attached to the MSLQ in order to facilitate the completion and return of both instruments simultaneously. As was the case with the MSLQ, the Demographic Information Questionnaire was completed by students outside of class and returned during the first week of the quarter.

Additional information gathered using the Demographic Information Questionnaire was used as a means of describing the students taking part in the study. This description was intended to facilitate replication and/or critical analysis of this research.

**Instructor Characteristics**

Instructor characteristics were also considered as possible factors affecting student cognitive performance and as a necessary body of information needed to facilitate replication of the study. An instrument developed and used by Pickford (1988) was employed (Appendix F). This
instrument considered the instructors' previous experience with the subject matter in terms of prior education, teaching, research, and community experiences. Also determined were the number of years of teaching experience which the instructor had, quarters or semesters that he/she had taught the course included in the study, and the number of years of their previous related work experience. In the second portion of the instrument, the instructor was asked to rate his/her level of undergraduate, graduate, and research involvement in the course content area as well as his/her degree of involvement in the agricultural community on issues related to the course content.

Pickford (1988) reported that the validity of this instrument was established by a panel of experts. Reliability of the instrument has not been statistically assessed as it has only been used to secure responses from eight individuals thus far. The instructors completed this instrument during the final week of the quarter.

Data Analysis

A broad range of data were collected in order to address the research questions which guided this study. The following procedures were used in order to analyze the raw data collected.

Statistical analyses were conducted using the Statistical Package for the Social Sciences PC version
Raw data were first recorded on a computer diskette using the Freestyle word processing program. An IBM-PC computer using the SPSS-PC+ program was then employed to access and analyze data files.

Each student in the study represented a case in the data set and was identified by a code number assigned each individual by the researcher. Instructor data was analyzed separately from student data. Only those values required to calculate correlation coefficients were transferred from the instructor data to the student data set.

The following sections present specific procedures followed in order to arrive at the values entered into the data set.

Cognitive Level of Instruction

Several steps were taken in order to arrive at values representative of the cognitive levels of instruction. Initially, the number of behaviors observed at each of the seven levels of cognition included in the Florida Taxonomy of Cognitive Behavior were totalled for each class observation. Following this step, the totals for each of the levels of cognition were summed for the three class observations of each instructor. This procedure provided values representing the frequencies of behaviors classified at each of the seven levels of cognition for each instructor.
In order to determine the relative occurrence of each of the levels of cognition for each of the instructors, a grand total of all behaviors observed at all levels of cognition during the three observations was calculated. The total number of behaviors exhibited by the instructor at each of the seven levels was divided by the grand total in order to determine the percentage of behaviors which each instructor exhibited at the various levels of cognition. These percentage values represented an interval measure of the degree to which each of the instructors' discourse occurred in the various levels of cognition.

A single value representing each of the instructors' relative cognitive level of instruction was calculated by multiplying the percentage values of each cognitive level by their respective cognitive weighting values (Table 3). These weighted cognitive scores at each level were summed in order to obtain a single interval score which was representative of the cognitive level of instruction of each professor.

Cognitive Level of Assignments, Tests and Quizzes

The cognitive levels of assignments, tests and quizzes were evaluated by the researcher as follows. Initially, each item included in an assignment, test or quiz was classified using the FTCB. The percentage of points assigned to each item by the instructor was then determined. Items at each of the seven levels of cognition were grouped
by level and the percentage of points allocated to each level was totalled. These values, representing the percentages of each of the levels of cognition assessed in the assignment, quiz or test, were multiplied by their respective cognitive weighting values (Table 3) in order to yield a weighted cognitive score at each of the seven levels for the assignment, quiz or test. The weighted cognitive scores at each level were then summed to obtain a single weighted cognitive score for each assignment, quiz or test.

The weighted scores were summed for all assignments of each instructor in order to provide a single value representative of the cognitive level of assignments. The weighted score for all quizzes and tests were also summed in order to provide a single value representative of the cognitive level of quizzes and tests. These values represented interval measures of the relative degree of cognitive performance expected of the students.

The two values calculated for each course (one for quizzes/tests and one for assignments) were included in the data set with each case to which they applied.

Cognitive Level of Performance

The cognitive level of performance by students was assessed using three different instruments for each student; the Developing Cognitive Abilities Test, the subject matter pretest, and the course final examination. Results of these tests were evaluated in the following manner.
The Developing Cognitive Abilities Test. As noted earlier, the DCAT included items at three levels of cognition. These levels were identified as general cognitive abilities, application skills and critical thinking skills. Because two sections of the test were used in this study and there were nine items included at each of the three cognitive levels in each section, each student had the opportunity to respond to 18 items at each level. The percentage of items correct at each of the three levels was determined for each student. A mean percentage correct at each level was then calculated for each class. This was done for both the DCAT pretest and posttest and these mean correct percentages at each level were used to compare the DCAT results.

Subject Matter Pretest. The student cognitive level of performance in the subject matter area was evaluated using a researcher-developed pretest. Table 4 illustrates the method used to assess the cognitive level of performance of each student on this pretest.

The student’s percent correct score at each level was multiplied by the percentage of questions at that level on the test and the cognitive weighting value for that level. This formula provided a weighted cognition score at each level for each student. Scores at each level were then summed to generate a total weighted cognition score for each student. In the example presented in Table 4, the student
had a total weighted cognition score of 22.5. The highest score possible in this example would have been 30.5. In order for a student to score 30.5 it would have been necessary for the individual to have a 100% correct score on items at each of the levels of cognition.

The total weighted cognition score represented an interval measure of each student's relative cognitive performance on the pretest. These individual scores were entered into the data set to facilitate further statistical analyses.

Table 4
Example of Method for Calculating Cognitive Performance Score

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Student's % Score</th>
<th>Percent of Test*</th>
<th>Cognition Wt. Value</th>
<th>Cognition Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>100</td>
<td>.20</td>
<td>.10</td>
<td>2.0</td>
</tr>
<tr>
<td>Translation</td>
<td>95</td>
<td>.10</td>
<td>.20</td>
<td>1.9</td>
</tr>
<tr>
<td>Interpretation</td>
<td>80</td>
<td>.10</td>
<td>.25</td>
<td>2.0</td>
</tr>
<tr>
<td>Application</td>
<td>75</td>
<td>.20</td>
<td>.30</td>
<td>4.5</td>
</tr>
<tr>
<td>Analysis</td>
<td>70</td>
<td>.20</td>
<td>.40</td>
<td>5.6</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0</td>
<td>.00</td>
<td>.50</td>
<td>0.0</td>
</tr>
<tr>
<td>Evaluation</td>
<td>65</td>
<td>.20</td>
<td>.50</td>
<td>6.5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>22.5</strong></td>
</tr>
</tbody>
</table>

* express as a decimal value
Course Final Examination. The procedure used to arrive at a value representative of students' cognitive performance on the course final examination was identical to that used with the subject matter pretest. The preceding section provides a detailed description of the procedure used to calculate this score.

The total weighted cognition scores calculated from the course final examinations represented an interval measure of the relative degree of student cognitive performance in the subject matter area. These individual scores were also entered into the data set for subsequent analyses.

Additional Student Variables

Instruments used to collect information concerning student motivation and previous experience required preliminary interpretation in order to facilitate the analysis of each of these variables. The following procedures were used to interpret the information provided on each of these instruments.

The Motivated Strategies Learning Questionnaire (MSLQ), which was used to assess student motivation, provided student responses to 40 statements which were rated on a Likert-type scale of 1 - 7 with 7 representing a statement indicative of the student and 1 representing a statement not indicative of the student. Student responses to items indicating positive student motivation were coded as the student responded. Responses to items indicating lack of
student motivation were coded using the inverse value on the scale. For example, if a student responded to the statement "If I don't do well in this course it is because of the instructor" by circling a 7 (very true of me), the response was coded as a 1.

The coded responses were totalled for each student and divided by 40 in order to obtain a mean motivation score. Higher scores reflected higher student motivation. These interval values were used for subsequent statistical analyses involving student motivation.

The information collected regarding student previous experience with the course content was primarily obtained through student responses of "yes" and "no" to a number of questions. Each response was coded 1 for "yes" or 0 for "no" and coded values were totalled for each student. The number of previous similar college courses taken by the student was added to the total number of "yes" responses obtained in order to obtain a score representing student previous experience. Higher scores reflected more previous experience by students in the subject matter area. These totals were the values used for later analyses considering student previous experience.

Other Instructor Variables

The Instructor's Previous Experience questionnaire (Appendix F) provided a single interval value based upon the amount of time spent in activities related to the course
content. Questions 1 through 4 were coded using values of 2, 1, or 0 based upon the degree of experience indicated with 2 representing considerable experience, 1 representing some experience and 0 representing no experience. The instructors' experience score was obtained by summing the coded values assigned to questions 1 through 4 and the values indicated by the instructor in items A, B, and C. The instructors' experience score was recorded in the data set for each student in that individuals’ class.

Analyses Conducted

For each of the variables considered, frequency distributions were generated in order to describe the nature of the variable in the population considered. Additionally, Pearson product moment correlation coefficients were calculated between the cognitive levels of performance on the course final examination and each of the following variables:

- cognitive levels of instructor discourse;
- cognitive levels of assignments;
- cognitive levels of tests and quizzes;
- student motivation;
- student academic ability;
- student previous experience with course content;
- instructor's previous experience with the course content.
CHAPTER IV
FINDINGS

The purpose of this study was to describe the cognitive level of teaching and student performance in selected Ohio State University College of Agriculture courses. The major variables of interest considered in the study included the ability of students to perform at the various levels of cognition upon entering and completing the course as well as the cognitive levels of instructor discourse and course assignments and tests. Additional variables considered included student motivation, student academic ability, student prior experience and instructor experience.

The population of this study consisted of 127 students enrolled in four purposefully selected introductory level courses in the Ohio State University College of Agriculture. Generalization beyond these four classes was not expressed nor intended.

Students' cognitive performance was assessed using a common pretest and posttest entitled the Developing Cognitive Abilities Test. Additionally, cognitive performance in the subject matter area was determined at the beginning of the quarter using researcher-developed pretests.
for each course and at the close of the quarter using the course final examination. Students' cognitive performance on the course final examination was considered to be the primary outcome variable of interest. The percentage of students completing each of these tests are reported by course.

Three types of course experiences were assessed using the Florida Taxonomy of Cognitive Behavior. These were the cognitive levels of instructor discourse, tests and quizzes, and assignments.

Student characteristics considered in the study included student academic ability as indicated by ACT composite scores, student previous experience, and student motivation. The Demographic Information Questionnaire and Motivated Strategies Learning Questionnaire were used to collect information concerning student motivation and student previous experience. ACT scores were obtained from students' university academic records.

Information regarding teacher characteristics was secured through the Instructor Previous Experience Questionnaire.

Included in this chapter is a brief overview of population characteristics followed by a detailed description of findings for each course studied. Findings concerning relationships between variables of interest are presented at the close of the chapter.
Population Characteristics

The population of this study was 127 students enrolled in four introductory level courses in the Ohio State University College of Agriculture during Spring Quarter, 1989. Demographic information describing these students was collected from 108 individuals, or 85% of the population. The following percentages and means reported are those representative of those 108 individuals in the population for which data was secured unless otherwise noted.

Inasmuch as all courses included in the study were at the introductory level it was interesting to find a greater percentage of juniors and seniors enrolled in these courses than freshmen and sophomores. In fact, nearly 30% of the students in the study were classified as seniors while 27% were sophomores, 23% were juniors and 20% were freshmen.

The ages of these students were consistent with those expected of the class ranks reported. Approximately two-thirds (67.6%) of the population were between the ages of 19 and 22. Students between the ages of 23 and 34 made up 27.8% of the individuals in the study while 18 year olds made up the remaining 5.6% of the population.

As might be expected of students enrolled in introductory level courses, few had completed more than one college course which was similar to the course involved in the study. Sixty percent of the students had taken no similar courses while approximately 20% had taken one
comparable course. The remaining 20% of the individuals studied had taken from two to eight similar courses.

Previous experience in a number of other areas related to the course subject matter was limited as well. Fewer than 40% of the students in the population had work experience in the subject matter area while less than 30% had any appreciable 4-H, FFA, or vocational agriculture experience in the subject matter area (28.7%, 20.4%, and 17.6% respectively). Sixteen percent of the population indicated that the course in which they were enrolled involved concepts related to those included in high school courses that they had taken.

The academic ability of the students involved in the study, as indicated by their ACT composite score, varied considerably. Scores reported by students ranged from a low of 11 to a high of 33 with a mean of 21.02. Thirty percent of the students had scores of 18 or lower, 30% had scores between 19 and 22, 30% had scores from 23 to 26, and the remaining 10% of the students' scores were 27 or greater. It should be noted that these percentages represent 106 of the 127 students in the study (83.5%). Several individuals in the study had not taken the ACT.

A final area of demographic information considered involved the gender and ethnic background of those individuals involved in the study. There were more males than females enrolled in the courses studied.
Approximately 61% of the students were male and 39% were female. These percentages varied considerably in some courses however, as will be evidenced in the following descriptions of individual courses. Nearly all students, both male and female, were caucasian (98%).

Course Characteristics

The following sections present a detailed explanation of findings in each of the four courses included in the study. These findings focused upon five areas which included: 1) unique student characteristics, 2) a description of instructor characteristics, 3) the cognitive level of instruction associated with teacher discourse, tests and quizzes, and assignments, 4) student performance on the Developing Cognitive Abilities Test at the beginning and upon completion of the course, and 5) student cognitive performance on subject matter specific examinations at the beginning and upon completion of the course. Comparisons of specific points of interest among courses have been relegated, in part, to the reader.

Agricultural Economics

The agricultural economics class studied had a total enrollment of 25 students. The following sections describe characteristics of these students and the instructor as well as the cognitive levels of instruction and student performance in the class.
**Student Characteristics**

Fourteen individuals (56% of the class) responded to the Demographic Information Questionnaire and Motivated Strategies for Learning Questionnaire which provided the following information. Approximately 50% of the agricultural economics students were either juniors or seniors and 43% of the remaining students were freshmen. Nearly two thirds (64.3%) of these individuals were between the ages of 18 and 20 and only one individual indicated that he/she was older than 23 years of age. Two thirds (66.7%) of the students were male and all were Caucasian with the exception of two Asian Americans in the class. ACT scores of the students in the class ranged from 15 to 27 with a mean of 20.8 (sd = 3.7) which was slightly below the population mean. ACT scores were obtained for 80% of the students in this class.

Previous experience of the student in this class varied to a greater extent than that of the population. While 43% of the group had taken no economics course in college previously, 21% had taken one course and 36% had taken two, three or four college economics courses. Over 85% of the group had no work experience related to agricultural economics. Fourteen percent of the group had two or more years of high school vocational agriculture and FFA experience involving agricultural economics and seven percent reported that they had similar experience through
4-H. Twenty-one percent of the students reported that they had taken high school courses that focused upon economic concepts to some extent.

A previous experience score was calculated for each student based upon the total number of previous college courses taken and whether the student had been involved in any related work experience, high school activities or high school courses. Previous experience scores in the class ranged from zero to seven with a mean of 3.0. Twenty-one percent of the students in the class had no previous experience whatsoever while 36% had limited experience (scores of 1 or 2). Students with scores of 4 or 5 made up 21% of the class as did those with scores of 6 or 7.

Motivation was a final student characteristic considered. Responses to 40 items on the MSLQ were provided on a seven point Likert-type scale. These responses were averaged for each student to obtain a student motivation score. The possible range of scores was from 1.0 (low student motivation) to 7.0 (high student motivation). Scores for respondents in the agricultural economics class ranged from 4.68 to 5.58 with a mean of 5.0 (sd = .26). This mean score was below that of the population (5.18) and indicated that students in this class were slightly less motivated than those in other classes studied. A review of mean class motivation scores verified that this class had the lowest average score.
Instructor Characteristics

The instructor for this agricultural economics class had taught this same course, or a similar course, during two previous quarters and had a total of two years of university teaching experience. Additionally, she had eight years of experience in agricultural economics outside of teaching in the university setting. This instructor had taken a similar course as an undergraduate and served as a teaching associate for a similar course during her graduate education as well. She had some involvement in research related to the materials and concepts presented in the course and some experience in the agricultural community with issues related to the course content. Her major areas of expertise were agricultural marketing and agricultural policy.

Using the procedure outlined on page 61, an instructor previous experience score was calculated for each of the professors studied. These scores ranged from a high of 57 to a low of 17. The score of 17 represented the agricultural economics instructor indicating that she had less experience in the subject matter area than other professors taking part in the study.

Cognitive Level of Instructor Discourse

The cognitive level of instructor discourse was assessed using the Florida Taxonomy of Cognitive Behavior (FTCB). Three agricultural economics classes were observed and audio recorded and the cognitive level of instructor
discourse was determined using the procedure outlined on pages 55-56. Table 5 presents frequencies and percentages of behaviors observed in the agricultural economics classes at each of the seven levels of cognition included on the FTCB.

Frequencies reported in the second observation were lower because of an abbreviated class period of 35 minutes rather than the normal 75 minutes. If these values were doubled however, it becomes apparent that the cognitive

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Frequencies</th>
<th></th>
<th></th>
<th>Total</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Obs. 1</td>
<td>Obs. 2</td>
<td>Obs. 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>39</td>
<td>18</td>
<td>38</td>
<td>95</td>
<td>34.55</td>
</tr>
<tr>
<td>Translation</td>
<td>24</td>
<td>13</td>
<td>27</td>
<td>64</td>
<td>23.27</td>
</tr>
<tr>
<td>Interpretation</td>
<td>17</td>
<td>11</td>
<td>22</td>
<td>50</td>
<td>18.18</td>
</tr>
<tr>
<td>Application</td>
<td>6</td>
<td>1</td>
<td>8</td>
<td>15</td>
<td>5.45</td>
</tr>
<tr>
<td>Analysis</td>
<td>19</td>
<td>8</td>
<td>14</td>
<td>41</td>
<td>14.91</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Evaluation</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>10</td>
<td>3.64</td>
</tr>
<tr>
<td></td>
<td><strong>110</strong></td>
<td><strong>55</strong></td>
<td><strong>110</strong></td>
<td><strong>275</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Table 5
Cognitive Levels of Instructor Discourse in Agricultural Economics Classes
level of instruction was consistent during all three periods observed. The greatest percentage of teacher discourse (34.6%) was devoted to providing specific facts. These behaviors, along with those classified as translation, comprised 57.9% of the observed behaviors. Less than six percent of the classroom instruction occurred at the application and evaluation levels and no behaviors indicative of the synthesis level of cognition were observed.

The percentages reported at each level were multiplied by their respective cognitive weighting values (Table 3). These products were totalled to give an overall cognitive level of discourse score of 22.08 for this instructor. This was the highest such score among the four calculated. These scores ranged from 20.86 to 22.08.

Cognitive Level of Tests

Students in the agricultural economics course in this study were given three tests during the quarter prior to the final examination. The scores on these tests comprised 50% of the students' final grade making each test worth 16.67% of the students' final grade. Table 6 indicates the percentage of items on each test at the various levels of cognition. These percentages were determined using the value given each item on the tests by the instructor.

Nearly half of the value of the agricultural economics tests was devoted to items at the knowledge level of
cognition. Analysis was required for approximately 16% of the items while questions at the translation, interpretation, application, and evaluation levels each comprised from seven to eleven percent of the tests’ values. A single question requiring synthesis appeared in one of the three tests.

A cognitive score for each test was calculated by multiplying the percent of items at each of the levels of cognition by their respective cognitive weighting values (Table 3). These products were summed for each test and

Table 6
Cognitive Levels of Agricultural Economics Tests

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Percent</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Test 3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>48.00</td>
<td>44.00</td>
<td>54.00</td>
<td></td>
<td>48.67</td>
</tr>
<tr>
<td>Translation</td>
<td>11.00</td>
<td>6.00</td>
<td>8.00</td>
<td></td>
<td>8.33</td>
</tr>
<tr>
<td>Interpretation</td>
<td>5.00</td>
<td>10.00</td>
<td>10.00</td>
<td></td>
<td>8.33</td>
</tr>
<tr>
<td>Application</td>
<td>14.00</td>
<td>8.00</td>
<td>10.67</td>
<td></td>
<td>10.89</td>
</tr>
<tr>
<td>Analysis</td>
<td>16.00</td>
<td>22.00</td>
<td>10.00</td>
<td></td>
<td>16.00</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.00</td>
<td>0.00</td>
<td>1.67</td>
<td></td>
<td>0.56</td>
</tr>
<tr>
<td>Evaluation</td>
<td>6.00</td>
<td>10.00</td>
<td>5.67</td>
<td></td>
<td>7.22</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td></td>
<td>100.00</td>
</tr>
</tbody>
</table>
multiplied by \(0.1667\), or the percentage of the final grade which each test represented. The resulting values, 3.64, 3.95 and 4.64, were considered the weighted cognitive scores of each test. The total weighted cognitive score for the three tests was 12.23 which was the highest such value obtained for any of the courses studied.

**Cognitive Level of Assignments**

Students in the agricultural economics course were to complete five homework assignments which contributed 20% to their total grade. Table 7 reports the percentage of each of the levels of cognition appearing in these assignments.

**Table 7**

**Cognitive Levels of Agricultural Economics Assignments**

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Percent of Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>50.00  0.00  0.00  0.00  16.67  13.33</td>
</tr>
<tr>
<td>Translation</td>
<td>16.67  25.00  25.00  0.00  16.67  16.67</td>
</tr>
<tr>
<td>Interpretation</td>
<td>33.33  0.00  8.33  0.00  25.00  13.33</td>
</tr>
<tr>
<td>Application</td>
<td>0.00  37.50  58.33  66.66  33.33  39.17</td>
</tr>
<tr>
<td>Analysis</td>
<td>0.00  12.50  8.33  33.33  8.33  12.50</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.00  0.00  0.00  0.00  0.00  0.00</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0.00  25.00  0.00  0.00  0.00  5.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100.00 100.00 99.99 99.99 100.00 100.00</td>
</tr>
</tbody>
</table>
The cognitive level of agricultural economics homework assignments varied considerably as evidenced by the lower levels of cognition assessed in assignment one versus the focus upon application and analysis required in assignment four. The assignments clearly tended to focus upon the knowledge level of cognition however. As with the tests, virtually no synthesis was required and little evaluation was expected as well.

The weighted cognitive value of assignments was determined using the same procedure described for obtaining weighted cognitive test values. While the cognitive level scores of assignments two through five was as high or higher than those of the three tests, their weighted cognition scores were much lower as each assignment was worth four percent of the students’ final grade. The total weighted cognition score for assignments was 5.25 which was among the lower pair of the four such scores calculated in the study. Total weighted cognition scores for all assignments in other courses ranged from 3.80 to 24.33

**Student Performance on the Developing Cognitive Abilities Test**

The Developing Cognitive Abilities Test was used as a common measure of students’ cognitive performance within each class as well as among the four courses. The DCAT assessed student verbal and quantitative performance at three levels, general cognitive abilities (knowledge,
translation, and interpretation), application skills and critical thinking skills (analysis, synthesis, and evaluation). The test was administered at both the beginning and completion of the course. Ninety-two percent of the students in the agricultural economics course completed the pretest while 56% completed the posttest. A high rate of absenteeism in agricultural economics courses was reported by the instructor which was reflected in the number of students completing the DCAT posttest. Means reported are based upon all data collected.

Table 8
Agricultural Economics Student Performance on the Developing Cognitive Abilities Test

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean %</td>
<td>sd</td>
</tr>
<tr>
<td></td>
<td>correct</td>
<td></td>
</tr>
<tr>
<td>General cognitive abilities</td>
<td>79.87</td>
<td>14.21</td>
</tr>
<tr>
<td>Application skills</td>
<td>80.44</td>
<td>13.23</td>
</tr>
<tr>
<td>Critical thinking skills</td>
<td>55.57</td>
<td>20.47</td>
</tr>
<tr>
<td>Grand mean</td>
<td>71.96</td>
<td></td>
</tr>
<tr>
<td>n = 23</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 8 presents means and standard deviations of the percent correct at each of the levels of cognition represented on the DCAT. Pretest means indicated that the average student had 14 or 15 items correct out of a possible 18 on both the general cognitive abilities and application skills sections while 10 of 18 items on the critical thinking section were answered correctly. The standard deviations indicated more variance in scores on the critical thinking section as well which was reflected by a range of 28% to 94% correct on this section of the pretest. General cognitive ability and application skills sections both had percentages correct ranging from 56% to 100% on the pretest.

Posttest scores reflected a decrease in the number of general cognitive ability items answered correctly but an increase in the number of critical thinking skills questions that were correct (when compared with the pretest). The average number of general cognitive ability items correct decreased by one while the average number of critical thinking skills questions correct increased by one. The mean number of application skills items correct was similar on the pretest and posttest.

Grand means for the pretest and posttest indicated little change in overall student performance between the two tests. While the average number of correct items was actually fewer on the posttest, cognitive weighting of performance at each of the levels indicated that the
weighted score was higher on the posttest than on the pretest (61.51 versus 59.90). This was based upon weighting values of .10, .30, and .50 assigned to the general cognitive abilities, application skills and critical thinking skills areas respectively.

**Agricultural Economics Pretest**

A 54 item multiple choice subject matter pretest was administered to agricultural economics students during the first week of the quarter. Items on the test represented each of the levels of cognition with the exception of the synthesis level. Twenty-three of 25 students in the class (92%) took this pretest. Table 9 presents the percentage of items included at each of the levels of cognition on the pretest as well as the number of items included at each level, the mean number of correct responses at each level, and the percentage of items correctly answered at each level.

Students were able to correctly answer approximately one half of the knowledge level questions on the pretest and slightly more than one third of the interpretation and application level questions. They averaged one third or less correct responses at the translation, analysis and evaluation levels. The mean percentage of items correct for the entire test was 36.59% which was the lowest such average for any of the courses studied.
Weighted cognition scores were calculated for each individual by multiplying the percentage of items he/she had correct at each level of cognition by the cognitive weighting value for each level (Table 3). These products were summed to arrive at a single weighted cognition score for each student. Table 10 presents the distribution of these scores for the agricultural economics class.

Table 9
Student Cognitive Performance On Agricultural Economics Pretest

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Percent of Test</th>
<th>Number</th>
<th>Mean correct</th>
<th>Percent correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>16.67</td>
<td>9</td>
<td>4.43</td>
<td>49.22</td>
</tr>
<tr>
<td>Translation</td>
<td>14.81</td>
<td>8</td>
<td>2.48</td>
<td>31.00</td>
</tr>
<tr>
<td>Interpretation</td>
<td>11.11</td>
<td>6</td>
<td>2.22</td>
<td>37.00</td>
</tr>
<tr>
<td>Application</td>
<td>25.93</td>
<td>14</td>
<td>5.28</td>
<td>37.71</td>
</tr>
<tr>
<td>Analysis</td>
<td>20.37</td>
<td>11</td>
<td>3.35</td>
<td>30.45</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Evaluation</td>
<td>11.11</td>
<td>6</td>
<td>2.00</td>
<td>33.33</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.00</strong></td>
<td><strong>54</strong></td>
<td><strong>19.61</strong></td>
<td></td>
</tr>
</tbody>
</table>

n = 23
The potential range of weighted cognition scores for the agricultural economics pretest was from zero to 28.90. Actual scores ranged from 3.71 to 15.18 with a majority of the students (57%) scoring between 8.00 and 11.00. The mean weighted cognition score for this class was 9.90 (sd = 2.82). Inasmuch as the possible was 28.90, this mean indicated that the average class performance was approximately one third (34%) of the potential cognitive level of performance which could be evidenced by the pretest.

Table 10
Weighted Cognition Scores on Agricultural Economics Pretest

<table>
<thead>
<tr>
<th>Score</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.51 - 5.50</td>
<td>1</td>
<td>4.35</td>
</tr>
<tr>
<td>5.51 - 7.50</td>
<td>3</td>
<td>13.04</td>
</tr>
<tr>
<td>7.51 - 9.50</td>
<td>6</td>
<td>26.09</td>
</tr>
<tr>
<td>9.51 - 11.50</td>
<td>8</td>
<td>34.78</td>
</tr>
<tr>
<td>11.51 - 13.50</td>
<td>1</td>
<td>4.35</td>
</tr>
<tr>
<td>13.51 - 15.50</td>
<td>4</td>
<td>17.39</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Possible 0.00 - 28.90
Mean 9.90
sd 2.82
Agricultural Economics Final Examination

A 50 item agricultural economics final examination was developed by the instructor and administered at the close of the quarter. This examination included items at all levels of cognition with the exception of the synthesis level. Twenty-three of 25 students (92%) completed the final examination prior to the final day of the quarter.

Table 11
Student Cognitive Performance On Agricultural Economics Final Examination

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Percent of Exam</th>
<th>Number</th>
<th>Mean correct</th>
<th>Percent correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>40.00</td>
<td>20</td>
<td>12.00</td>
<td>60.00</td>
</tr>
<tr>
<td>Translation</td>
<td>8.00</td>
<td>4</td>
<td>2.92</td>
<td>73.00</td>
</tr>
<tr>
<td>Interpretation</td>
<td>4.00</td>
<td>2</td>
<td>1.00</td>
<td>50.00</td>
</tr>
<tr>
<td>Application</td>
<td>6.00</td>
<td>3</td>
<td>2.22</td>
<td>74.00</td>
</tr>
<tr>
<td>Analysis</td>
<td>14.00</td>
<td>7</td>
<td>3.61</td>
<td>51.57</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Evaluation</td>
<td>28.00</td>
<td>14</td>
<td>8.74</td>
<td>62.43</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.00</strong></td>
<td><strong>50</strong></td>
<td><strong>30.49</strong></td>
<td></td>
</tr>
</tbody>
</table>

n = 23
Table 11 presents the percentage of items included at each of the levels of cognition on the agricultural economics final examination as well as the number of items included at each level, the mean number of correct responses at each level, and the percentage of items correctly answered at each level. Students had more than 50% of the items correct at each of the levels of cognition. Performance was highest at the translation and application levels where more than 70% of the items were answered correctly. Students also averaged more than 60% correct at the knowledge and evaluation levels and approximately 50% correct at the interpretation and analysis levels. The mean percentage correct on all items on the final examination was 61% which was considerably higher than the mean percentage correct on the agricultural economics pretest (37%).

Weighted cognitive scores on the final examination were calculated for individual students and are reported in Table 12. Scores ranged from 10.20 to 23.80. The maximum possible score was 28.00. More than one half of the students (56.5%) scored between 14.00 and 18.00. The mean weighted cognitive score was 16.86 (sd = 3.0) indicating that students had achieved 60% of the potential cognitive level of performance which could be evidenced by the final exam.
Table 12
Weighted Cognition Scores on Agricultural Economics
Final Examination

<table>
<thead>
<tr>
<th>Score</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.01 - 12.00</td>
<td>1</td>
<td>4.35</td>
</tr>
<tr>
<td>12.01 - 14.00</td>
<td>1</td>
<td>4.35</td>
</tr>
<tr>
<td>14.01 - 16.00</td>
<td>10</td>
<td>43.48</td>
</tr>
<tr>
<td>16.01 - 18.00</td>
<td>3</td>
<td>13.04</td>
</tr>
<tr>
<td>18.01 - 20.00</td>
<td>5</td>
<td>21.74</td>
</tr>
<tr>
<td>20.01 - 22.00</td>
<td>2</td>
<td>8.69</td>
</tr>
<tr>
<td>22.01 - 24.00</td>
<td>1</td>
<td>4.35</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Possible 0.00 - 28.00  
Mean 16.86  
sd 3.00  

Dairy Science

The dairy science class which was studied had a total enrollment of 21 students. The following sections describe characteristics of these students and the instructor as well as the cognitive levels of instruction and student performance in the class.
Student Characteristics

Nineteen individuals (91% of the class) responded to the Demographic Information Questionnaire and Motivated Strategies for Learning Questionnaire which provided the following information. Slightly more than one half of the students (52.6%) enrolled in the dairy science course were seniors. Approximately one fourth (26.3%) were juniors while the remaining students (21.1%) were equally divided between freshman and sophomore rank. The average age of students in the class was 22 and ages reported ranged from 18 to 28. Over two thirds of the students in the class were female (68.4%) and all students were caucasians. ACT scores of the students in the class ranged from 16 to 33 with a mean of 22.9 (sd = 5.0). This mean was nearly two points higher than that of the population. Scores were obtained for 17 of 21 students in the course (81%).

Previous experience of the students enrolled in the dairy science course was comparable with that of the population. Over three fourths of the individuals in the class (79%) had taken no similar college courses previously. Those who had taken such courses reported completing no more than three similar courses prior to enrolling in the dairy science course studied. Forty-two percent of these students had some previous work experience in the field of dairy science and a similar percentage had two or more years of 4-H experience related to dairying. Thirty-seven percent of
the class had two or more years of vocational agriculture and FFA experience in the area of dairy science.

A previous experience score was calculated for each student based upon the total number of previous college courses taken and whether the student had been involved in any related work experience, high school activities or high school courses. Previous experience scores in the class ranged from zero to seven with a mean of 2.74. One student in the course had no previous experience whatsoever but students with limited previous experience (scores of one or two) comprised 42.1% of the class. Those with scores of three or four made up 31.6% of the class while students with considerable previous experience (scores of five, six or seven) represented 21.2% of the class.

Motivation was a final student characteristic considered. Responses to 40 items on the MSLQ were provided on a seven point Likert-type scale. These responses were averaged for each student to obtain a student motivation score. The possible range of scores was from 1.0 (low student motivation) to 7.0 (high student motivation). Scores for respondents in the dairy science course ranged from 4.53 to 6.15 with a mean of 5.25 (sd = .41). This mean score was above that of the population (5.18) as well as similar mean scores calculated for the remaining courses included in the study.
Instructor Characteristics

The instructor for this dairy science class had, by far, the most extensive previous experience in the course content of all instructors studied. He had taught a similar course during one quarter and twenty semesters previously and had a total of 31 years of university teaching experience. He had served as a teaching associate for a similar course during his graduate education and had been directly involved in research related to the material and concepts presented in the course. He also had some experience in the agricultural community with issues related to the course content. This instructor listed his major areas of expertise as dairy cattle management and physiology of lactation which were both areas considered in the course. Additionally, he authored a text used for this course and similar courses in other institutions.

Using the procedure outlined on page 61, an instructor previous experience score was calculated for each of the professors studied. These scores ranged from a high of 57 to a low of 17. As noted, this instructor had the highest such score (57) which was nearly double that of the next highest score (30).

Cognitive Level of Instructor Discourse

The cognitive level of instructor discourse was assessed using the Florida Taxonomy of Cognitive Behavior (FTCB). Table 13 presents frequencies and percentages of
behaviors observed in the dairy science classes at each of the seven levels of cognition included on the FTCB.

As was the case with the agricultural economics class, the percentage of behaviors observed at each of the levels of cognition did not vary greatly from observation to observation. Over one half of the behaviors identified were at the knowledge and translation levels of cognition (38.8% and 17.6% respectively). Nearly 23% of the instructor discourse was the interpretation level while 20% was at the application and analysis levels. No teacher discourse was

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Frequencies</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>26 42 39 107</td>
<td>38.77</td>
</tr>
<tr>
<td>Translation</td>
<td>16 12 21 49</td>
<td>17.75</td>
</tr>
<tr>
<td>Interpretation</td>
<td>19 25 19 63</td>
<td>22.83</td>
</tr>
<tr>
<td>Application</td>
<td>6 6 5 17</td>
<td>6.16</td>
</tr>
<tr>
<td>Analysis</td>
<td>15 14 9 38</td>
<td>13.77</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0 0 0 0</td>
<td>0.00</td>
</tr>
<tr>
<td>Evaluation</td>
<td>2 0 0 2</td>
<td>0.72</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>84 99 93 275</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Table 13
Cognitive Levels of Instructor Discourse in Dairy Science Classes
observed at the synthesis level and less than one percent was devoted to evaluation.

The percentages reported at each level were multiplied by their respective cognitive weighting values (Table 3). These products were totalled to give an overall cognitive level of discourse score of 20.86 for this instructor. This was the lowest such score among the four calculated. As noted earlier, these scores ranged from 20.86 to 22.08.

**Cognitive Level of Tests**

Students in the dairy science course studied were given two tests and a total of six brief quizzes during the quarter. Each of the tests contributed 20% to the students' final grade while the total contribution of quizzes was 10% of the students' final grade. Table 14 reports the percentage of items on each of the tests and the combination of six quizzes at the various levels of cognition. These percentages were determined using the value given each item by the instructor.

Nearly two thirds of the value (63.1%) of the dairy science tests and quizzes was devoted to items at the knowledge level of cognition. Another 21% of the items were at the interpretation level. Items requiring application comprised less than 10% of the tests and quizzes while analysis, evaluation, and translation items combined made up less than 10% of the tests and assignments. No synthesis level questions appeared on dairy science tests or quizzes.
A weighted cognition score for dairy science tests and quizzes was calculated using the procedure outlined on pages 56-57. The scores obtained were 3.05 for test one, 3.74 for test two and 1.82 for the combination of quizzes. The total weighted cognition score of tests and quizzes was 8.61 which was the lowest such score among the three instructors administering tests and/or quizzes in the courses studied (one instructor gave no tests or quizzes).

Cognitive Level of Assignments

Students in the dairy science course were expected to complete two types of assignments during the quarter. The first group of assignments given were periodic laboratory

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Quizzes</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>75.00</td>
<td>66.00</td>
<td>48.33</td>
<td>63.11</td>
</tr>
<tr>
<td>Translation</td>
<td>0.00</td>
<td>0.00</td>
<td>1.67</td>
<td>0.56</td>
</tr>
<tr>
<td>Interpretation</td>
<td>15.00</td>
<td>10.00</td>
<td>38.33</td>
<td>21.11</td>
</tr>
<tr>
<td>Application</td>
<td>0.00</td>
<td>10.00</td>
<td>11.67</td>
<td>7.22</td>
</tr>
<tr>
<td>Analysis</td>
<td>10.00</td>
<td>4.00</td>
<td>0.00</td>
<td>4.67</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0.00</td>
<td>10.00</td>
<td>0.00</td>
<td>3.33</td>
</tr>
</tbody>
</table>

| Total              | 100.00 | 100.00 | 100.00  | 100.00|
exercises which were included as 10% of the students' final grade. These exercises involved application of principles considered in the laboratory portion of the course and were assessed as requiring 50% application behaviors and 50% evaluation behaviors.

The second assignment given students in the dairy science course was a choice between reviewing three articles appearing in the *Journal of Dairy Science* or completing a term paper on a specific topic of interest in the field of dairy science. Either assignment contributed 20% to the students' final grade. Students selecting to review three articles were expected to be operating at the cognitive level of evaluation while students preparing a term paper were required to operate at the synthesis level of cognition.

Weighted cognition scores were calculated for these assignments using the procedure outlined on pages 56-57. The weighted cognition score for the laboratory exercises was found to be 4.0 while the score for either the article or the term paper assignment was 10.0. The total weighted cognition score for dairy science assignments was 14.0 which was the second highest value among the four assignment weighted cognition scores calculated. Assignment weighted cognition scores ranged from 3.88 to 24.33 in the courses studied.
Student Performance on the Developing Cognitive Abilities Test

The Developing Cognitive Abilities Test assessed student cognitive performance at three levels, general cognitive abilities, application skills, and critical thinking skills. The test was administered at both the beginning and completion of the course. Ninety percent of the students in the dairy science course completed the pretest while 86% completed the posttest.

Table 15 presents means and standard deviations of the percent correct at each of the levels of cognition represented on the DCAT. Pretest means indicated that the average student had 15 of 18 items correct on both the general cognitive abilities and application skills sections of the tests. Similar results were found on the posttest for these two sections. Students scored virtually the same on the critical thinking skills section of both the pretest and posttest also but averaged 12 of 18 items correct on this section. Smaller standard deviations were found with scores on the general cognitive and applications skills sections of the pretest and posttest. The typical range of scores in these four areas was from approximately 60% correct to 100% correct. Critical thinking skills scores varied to a greater extent and ranged from 17% correct to 100% correct.
Grand means on the pretest and posttest indicated virtually no change in overall average student performance. Students average between 42 and 43 (of 54) items correct on both the DCAT pretest and posttest. While little change in student performance on the DCAT was evidenced, it should be noted that dairy science students consistently averaged approximately four percentage points higher on each of the sections of the pretest and posttest than the average percent correct for the population. No other class consistently scored above the population means on the DCAT.

Table 15
Dairy Science Student Performance on the Developing Cognitive Abilities Test

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Pretest</th>
<th></th>
<th>Posttest</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean %</td>
<td>sd</td>
<td>Mean %</td>
<td>sd</td>
</tr>
<tr>
<td>General cognitive abilities</td>
<td>85.90</td>
<td>13.96</td>
<td>84.00</td>
<td>13.35</td>
</tr>
<tr>
<td>Application skills</td>
<td>85.16</td>
<td>12.27</td>
<td>85.06</td>
<td>12.64</td>
</tr>
<tr>
<td>Critical thinking skills</td>
<td>66.84</td>
<td>21.26</td>
<td>66.39</td>
<td>21.27</td>
</tr>
</tbody>
</table>

Grand mean

<table>
<thead>
<tr>
<th></th>
<th>Pretest</th>
<th></th>
<th>Posttest</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 19</td>
<td>71.96</td>
<td></td>
<td>71.02</td>
<td></td>
</tr>
<tr>
<td>n = 18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Dairy Science Pretest

A 50 item multiple choice subject matter pretest was administered to dairy science students during the first week of the quarter. Items on the test represented each of the levels of cognition with the exception of the synthesis level. Ninety percent (19 of 21) of the students enrolled in the class completed the pretest.

Table 16 presents the percentage of items included at each of the levels of cognition on the dairy science pretest.

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Percent of Test</th>
<th>Mean correct</th>
<th>Percent correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>24.00</td>
<td>5.79</td>
<td>48.25</td>
</tr>
<tr>
<td>Translation</td>
<td>10.00</td>
<td>3.11</td>
<td>62.20</td>
</tr>
<tr>
<td>Interpretation</td>
<td>24.00</td>
<td>5.63</td>
<td>46.91</td>
</tr>
<tr>
<td>Application</td>
<td>12.00</td>
<td>2.69</td>
<td>44.83</td>
</tr>
<tr>
<td>Analysis</td>
<td>20.00</td>
<td>5.42</td>
<td>54.20</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Evaluation</td>
<td>10.00</td>
<td>3.21</td>
<td>64.20</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td>25.85</td>
<td></td>
</tr>
</tbody>
</table>

n = 19
as well as the number of items included at each level, the mean number of correct responses at each level, and the percentage of items correctly answered at each level.

Students were able to answer approximately one half of all items on the dairy science pretest correctly. The percentage of items answered correctly at each level of cognition varied from 45% at the application level to 64% at the evaluation level indicating that there were no overwhelming differences in the students' ability to correctly answer questions at each of the levels present. The mean percent correct on the dairy science pretest, 51.68, was well above similar values determined for other course pretests in the study (40.92, 38.67, and 36.59) indicating that students in this class were more knowledgeable in the subject matter area at the beginning of the course than students enrolled in other courses.

Weighted cognition scores were calculated for each individual by multiplying the percentage of items he/she had correct at each level of cognition by the cognitive weighting value for each level. These products were summed to arrive at a single weighted cognition score for each student. Table 17 presents the distribution of these scores for the dairy science class.

The potential range of weighted cognition scores for the dairy science pretest was from zero to 27.00. Actual scores ranged from 8.30 to 19.50. Thirty-one point six
percent of the students had scores between 8.30 and 12.00, 31.6% had scores between 12.01 and 16.00 and 31.6% had scores from 16.01 to 18.00. The single student represented in the final range shown had a score of 19.50.

The mean weighted cognition score on the dairy science pretest was 14.05 (sd = 3.23). Inasmuch as the possible score was 27.0, this mean indicated that the average class performance was approximately one half (52%) of the potential cognitive level of performance which could be evidenced by the pretest. No other class approached this level of performance on the subject matter pretest.

Table 17

Weighted Cognition Scores on Dairy Science Pretest

<table>
<thead>
<tr>
<th>Score</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.01 - 10.00</td>
<td>2</td>
<td>10.53</td>
</tr>
<tr>
<td>10.01 - 12.00</td>
<td>4</td>
<td>21.05</td>
</tr>
<tr>
<td>12.01 - 14.00</td>
<td>4</td>
<td>21.05</td>
</tr>
<tr>
<td>14.01 - 16.00</td>
<td>2</td>
<td>10.53</td>
</tr>
<tr>
<td>16.01 - 18.00</td>
<td>6</td>
<td>31.58</td>
</tr>
<tr>
<td>18.01 - 20.00</td>
<td>1</td>
<td>5.26</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Possible range 0.00 - 27.00

Mean 14.05

sd 3.23
Dairy Science Final Examination

A final examination consisting of discussion, short answer, multiple choice and fill in the blank items was developed by the dairy science instructor. This examination included items at the knowledge, interpretation, application, analysis and synthesis levels of cognition. No items at the translation or evaluation levels were included. Seventeen of 21 students in the class (81%) took the final examination.

Table 18
Student Cognitive Performance On Dairy Science Final Examination

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Percent of Exam</th>
<th>Mean Percent Correct On Exam</th>
<th>Percent Correct Each Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>50.00</td>
<td>34.47</td>
<td>68.94</td>
</tr>
<tr>
<td>Translation</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Interpretation</td>
<td>10.00</td>
<td>6.35</td>
<td>63.50</td>
</tr>
<tr>
<td>Application</td>
<td>14.00</td>
<td>11.35</td>
<td>81.07</td>
</tr>
<tr>
<td>Analysis</td>
<td>20.00</td>
<td>17.41</td>
<td>87.05</td>
</tr>
<tr>
<td>Synthesis</td>
<td>6.00</td>
<td>6.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td>75.58</td>
<td></td>
</tr>
</tbody>
</table>

n = 21
Table 18 presents the average cognitive performance of students at each of the levels of cognition on the dairy science final examination. In contrast to the subject matter pretest, not all items were given an equal value. For this reason only percentages are reported.

As was the case on the pretest, student performance was exceptional on items at the higher levels of cognition. All students answered the synthesis level question correctly and had more than 80% of the items at the application and analysis levels correct. Three fourths (75%) of the knowledge level questions were answered correctly while approximately 63% of the interpretation level questions were correct. The mean percentage of items correct on the dairy science final was 78.6% which was well above the comparable percentage posted on the dairy science pretest and greater than similar percentages found in other courses studied.

Weighted cognition scores on the final examination were calculated for individual students and are reported in Table 19. Scores ranged from a 15.2 to 21.7 out of a possible 22.7. Over 50% of the students (52.9%) had weighted cognition scores that were greater than 19.0. An additional 41% had scores between 17.1 and 19.0. The mean weighted cognition score for this class was 19.1 which indicated that students had achieved approximately 84% of the potential cognitive level of performance which could be evidenced by the final examination.
Table 19
Weighted Cognition Scores on Dairy Science
Final Examination

<table>
<thead>
<tr>
<th>Score</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.01 - 16.00</td>
<td>1</td>
<td>5.88</td>
</tr>
<tr>
<td>16.01 - 17.00</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>17.01 - 18.00</td>
<td>3</td>
<td>17.65</td>
</tr>
<tr>
<td>18.01 - 19.00</td>
<td>4</td>
<td>23.54</td>
</tr>
<tr>
<td>19.01 - 20.00</td>
<td>2</td>
<td>11.76</td>
</tr>
<tr>
<td>20.01 - 21.00</td>
<td>6</td>
<td>35.29</td>
</tr>
<tr>
<td>21.01 - 22.00</td>
<td>1</td>
<td>5.88</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Possible range 0.00 - 22.70
Mean 19.11
sd 1.65

Food Science and Nutrition

The food science and nutrition course studied had a total enrollment of 37 students. The following sections describe characteristics of these students and the instructor as well as the cognitive levels of instruction and student performance in the class.


**Student Characteristics**

Thirty-one individuals (84% of the class) responded to the Demographic Information Questionnaire and Motivated Strategies for Learning Questionnaire which provided the following information. Nearly one half of the students in the class (45%) were seniors and 35% were sophomores. The remaining 20% of the students enrolled were equally divided between freshman and junior rankings. Approximately two thirds (64.5%) of the food science and nutrition students studied were between the ages of 18 and 21. The ages of other students in the class ranged from 22 to 29. Twenty of the 31 students responding (65%) were male and all respondents were caucasian with the exception of one hispanic and one student of unknown ethnic origin. ACT scores of students in the food science course ranged from 11 to 28 with a mean of 20.9 (sd = 4.7). Scores were obtained from 33 (89%) of the students enrolled in the course.

Previous experience of students in this class was limited in comparison to student in other classes studied. Sixty-five percent of the students enrolled in the food science and nutrition course had taken no similar college courses previously. Twenty-three percent had taken one similar college course while 10% had taken two or three similar courses. One student reported taking eight similar college courses. Over 80% of the students enrolled in the course had no previous experience working in food science
related occupations. Nearly 40% of the class (38.7%) had two or more years of 4-H experience dealing with food science and nutrition while 19.4% of the students had two or more years of experience with aspects of food science and nutrition in vocational agriculture courses and FFA activities.

A previous experience score was calculated for each student based upon the total number of previous college courses taken and whether the student had been involved in any related work experience, high school activities or high school courses. Previous experience scores in the class ranged from zero to eight with a mean of 2.3. While 13% of the class had absolutely no previous experience, 58% of the student had limited previous experience (scores of one or two). Students with a moderate degree of previous experience (scores of three or four) made up 16% of the class while those with considerable previous experience (scores of six, seven or eight) made up 13% of the class.

Motivation was a final student characteristic considered. Responses to items on the MSLQ were provided on a seven point scale. These responses were averaged for each student to obtain a student motivation score. The possible range of scores was from 1.0 (low student motivation) to 7.0 (high student motivation). Scores for respondents in the food science and nutrition course ranged from 3.68 to 6.10 with a mean of 5.14 (sd = .55). This mean score was
comparable with that of the population (5.18) and indicated that students in this class had an average degree of motivation when compared to other classes studied.

Instructor Characteristics

The instructor for this food science and nutrition course had taught this same course, or a similar course, during 16 previous quarters and had a total of 14 years of university teaching experience but had limited experience with the course content and materials beyond this. He had not had a similar course as an undergraduate nor had he served as a teaching assistant for such a course as a graduate student. He had limited involvement in the agricultural community with issues related to the materials and concepts presented in the course and had not been involved in research related to the course concepts and materials. This instructor reported his major areas of expertise as being proteins and food chemistry.

Using the procedure outlined on page 61, an instructor previous experience score was calculated for each of the professors studied. These scores ranged from a high of 57 to a low of 17. The food science and nutrition instructors' score was 30 which was the second highest such score posted. This score represented an average amount of previous experience when compared to the remaining instructors studied.
Cognitive Level of Instructor Discourse

The cognitive level of instructor discourse was assessed using the Florida Taxonomy of Cognitive Behavior (FTCB). Table 20 presents frequencies and percentages of behaviors observed in the food science and nutrition classes at each of the seven levels of cognition included on the FTCB.

The number of behaviors observed at each of the levels of cognition varied to a greater extent among observations.

Table 20
Cognitive Levels of Instructor Discourse in Food Science and Nutrition Classes

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Obs. 1</th>
<th>Obs. 2</th>
<th>Obs. 3</th>
<th>Total</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>30</td>
<td>42</td>
<td>30</td>
<td>102</td>
<td>45.33</td>
</tr>
<tr>
<td>Translation</td>
<td>4</td>
<td>5</td>
<td>8</td>
<td>17</td>
<td>7.56</td>
</tr>
<tr>
<td>Interpretation</td>
<td>6</td>
<td>15</td>
<td>14</td>
<td>35</td>
<td>15.56</td>
</tr>
<tr>
<td>Application</td>
<td>3</td>
<td>11</td>
<td>9</td>
<td>23</td>
<td>10.22</td>
</tr>
<tr>
<td>Analysis</td>
<td>18</td>
<td>18</td>
<td>11</td>
<td>47</td>
<td>20.89</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0.44</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>61</td>
<td>91</td>
<td>73</td>
<td>225</td>
<td>100.00</td>
</tr>
</tbody>
</table>
in this course than in the two previous courses reported. Additionally, this professor devoted a greater percentage of time to instruction at the knowledge level of cognition (45.3%) than did other instructors. Approximately 23% of the instruction occurred at the translation and interpretation levels of cognition while 21% occurred at the analysis level and less than 0.5% (one observed behavior) occurred at the synthesis level. No behaviors were observed at the evaluation level.

The percentages reported at each level were multiplied by their respective cognitive weighting values (Table 3). These products were totalled to give an overall cognitive level of discourse score of 21.63 for this instructor. The four overall cognitive level of discourse scores obtained ranged from 20.86 to 22.08.

Cognitive Level of Tests

Students in the food science and nutrition course considered were given two tests during the quarter prior to the final examination. Test items were comprised of multiple choice and short answer questions which were all of equal value. The scores on these tests comprised 50% of the students' final grade making each test worth 25% of the students' final grade. Table 21 indicates the percentage of items on each test at the various levels of cognition. These percentages were determined using the value given each item on the tests by the instructor.
Well over two thirds (70%) of the items appearing on the food science and nutrition tests were written at the knowledge level of cognition. Analysis was required on 15.5% of the items while synthesis and translation was necessary to correctly answer less than eight percent of the test questions. Two test questions (1.0%) were written at the interpretation level and no questions at the application or evaluation levels of cognition appeared on either test.

A cognitive score for each test was calculated by multiplying the percent of items at each of the levels of cognition by their respective cognitive weighting values.

Table 21
Cognitive Levels of Food Science and Nutrition Tests

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test 1</td>
</tr>
<tr>
<td>Knowledge</td>
<td>80.00</td>
</tr>
<tr>
<td>Translation</td>
<td>2.00</td>
</tr>
<tr>
<td>Interpretation</td>
<td>2.00</td>
</tr>
<tr>
<td>Application</td>
<td>0.00</td>
</tr>
<tr>
<td>Analysis</td>
<td>16.00</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.00</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>
These products were summed for each test and multiplied by .25, or the percentage of the final grade which each test represented. The resulting values, 3.82 and 3.38, were considered the weighted cognition scores of each test. The total weighted cognition score for the two tests was 9.2 which was among the higher pair of the four such values obtained in the study. These scores ranged from zero to 12.23 in the courses considered.

**Cognitive Level of Assignments**

Food science and nutrition students were expected to complete three types of assignments. The first was the development of a personal food chart indicating their nutritional intake for one week. This assignment was worth 6.25% of the final grade and was classified as requiring students to operate at the application level of cognition.

The second food science and nutrition assignment required students to develop a proposed diet consisting of fast food which was nutritionally balanced. Charts indicating the nutritional value of a variety of fast foods were provided. This assignment accounted for 3.75% of the students' final grade and required synthesis level thought.

The final assignment involved students responding to questions concerning discussion section activities (the discussion sections of this course was comparable to laboratory sections found in other courses in the study). These discussion section assignments were all at the
knowledge level of cognition and accounted for 10% of the students' final grade.

The weighted cognition score for assignments was determined using the same procedure described for obtaining weighted cognition scores of tests. The total weighted cognition score for the three assignments described was 3.80 which was the lowest such value found among the four courses studied. Other weighted cognition scores for assignments ranged from 5.25 to 24.33.

**Student Performance on the Developing Cognitive Abilities Test**

Ninety-two percent of the students in the food science and nutrition course completed the pretest while 81% completed the posttest. Means reported are based upon all data collected.

Table 22 presents means and standard deviations of the percent correct at each of the levels of cognition represented on the DCAT. As with students in other courses reported previously, no clear change of performance was observed between the pretest and posttest. On the general cognitive abilities section of the pretest and posttest, as well as the application skills section of the posttest, students averaged approximately 14 (of out of a possible 18) correct responses. On the applications skills section of the pretest student performance was slightly higher, averaging nearly 15 of 18 items correct. Means on the
critical thinking skills section of the pretest and posttest indicated that students had approximately 11 of 18 items correct on the average in these sections.

Standard deviations indicated a greater degree of variance on posttest scores than on pretest scores. This was reflected by ranges of 39%, 44% and 67% on the pretest while ranges on the posttest were 67%, 89% and 72% for the general cognitive abilities, application skills and critical thinking skills sections respectively. All ranges had a maximum value of 100% with the exception of the critical

Table 22

Food Science and Nutrition Student Performance on the Developing Cognitive Abilities Test

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Pretest</th>
<th></th>
<th>Posttest</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean %</td>
<td>sd</td>
<td>Mean %</td>
<td>sd</td>
</tr>
<tr>
<td>General cognitive abilities</td>
<td>77.97</td>
<td>11.39</td>
<td>78.27</td>
<td>14.00</td>
</tr>
<tr>
<td>Application skills</td>
<td>80.79</td>
<td>12.92</td>
<td>78.16</td>
<td>17.61</td>
</tr>
<tr>
<td>Critical thinking skills</td>
<td>62.08</td>
<td>18.31</td>
<td>60.52</td>
<td>18.33</td>
</tr>
</tbody>
</table>

Grand mean
n = 34
n = 31
thinking skills section on the posttest which had a maximum value of 89% correct.

Grand means for the pretest and posttest in this course indicated a slight decline in student performance from the pretest to the posttest. Mean scores of students in this course were greater than those of the agricultural economics students (71.96, 71.02) but less than those of horticulture (74.50, 76.28) and dairy science (79.30, 78.48) students. 

Food Science and Nutrition Pretest

A 30 item multiple choice subject matter pretest was administered to food science and nutrition students during the first week of the quarter. Items on the test represented each of the levels of cognition with the exception of the synthesis level. Thirty-three of 37 students in the class (89%) took this pretest.

Table 23 presents the percentage of items included at each of levels of cognition on the test. The number of items at each level, the mean number of correct responses to items at each level and the percentage of items correct at each level are also indicated.

Students were able to answer approximately one half of the application and analysis level questions on the pretest correctly and 40% of the knowledge and evaluation level questions correctly. Students were able to answer one of three translation level questions correctly but averaged less than one correct answer for each five interpretation
level questions. The mean percentage correct for the complete test was 42% which was higher than similar scores found in agricultural economics and horticulture courses (37% and 39% respectively) but lower than the percent correct on the dairy science pretest (52%).

Weighted cognition scores were calculated for each individual by multiplying the percentage of items he/she had correct at each level of cognition by the cognitive

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Percent of Test</th>
<th>Number</th>
<th>Mean Correct</th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>16.67</td>
<td>5</td>
<td>2.03</td>
<td>40.60</td>
</tr>
<tr>
<td>Translation</td>
<td>10.00</td>
<td>3</td>
<td>1.06</td>
<td>35.33</td>
</tr>
<tr>
<td>Interpretation</td>
<td>16.67</td>
<td>5</td>
<td>.79</td>
<td>15.80</td>
</tr>
<tr>
<td>Application</td>
<td>33.33</td>
<td>10</td>
<td>5.18</td>
<td>51.80</td>
</tr>
<tr>
<td>Analysis</td>
<td>16.67</td>
<td>5</td>
<td>2.37</td>
<td>47.40</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Evaluation</td>
<td>6.67</td>
<td>2</td>
<td>.82</td>
<td>41.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.00</strong></td>
<td><strong>30</strong></td>
<td><strong>12.25</strong></td>
<td></td>
</tr>
</tbody>
</table>

n = 33
weighting value for each level. These products were summed to arrive at a single weighted cognition score for each student. Table 24 presents the distribution of these scores for the food science class.

The potential range of weighted cognition scores for the food science and nutrition pretest was from zero to 27.87. Actual scores ranged from 7.16 to 18.49. One third of the students in the course scored between 7.16 and 10.50, one third scored between 10.51 and 12.50 while the remainder

Table 24
Weighted Cognition Scores on Food Science and Nutrition Pretest

<table>
<thead>
<tr>
<th>Score</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.01 - 9.00</td>
<td>7</td>
<td>21.21</td>
</tr>
<tr>
<td>9.01 - 11.00</td>
<td>5</td>
<td>15.15</td>
</tr>
<tr>
<td>11.01 - 13.00</td>
<td>12</td>
<td>36.36</td>
</tr>
<tr>
<td>13.01 - 15.00</td>
<td>5</td>
<td>15.15</td>
</tr>
<tr>
<td>15.01 - 17.00</td>
<td>3</td>
<td>9.10</td>
</tr>
<tr>
<td>17.01 - 19.00</td>
<td>1</td>
<td>3.03</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>33</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Possible 0.00 - 27.87

Mean 11.72
sd 2.76
of the class scored between 12.80 and 18.49. The mean weighted cognition score on this pretest was 11.72 (sd = 2.76) which indicated that the average class performance was 42% of the potential cognitive level of performance that could be evidenced by the pretest.

**Food Science and Nutrition Final Examination**

A 50 item food science and nutrition final examination was developed by the instructor and administered at the close of the quarter. The majority of items on this examination were at the knowledge level of cognition but items at the translation, interpretation, application and analysis levels were also included. No items at the synthesis or evaluation levels of cognition appeared on the food science and nutrition final exam. Thirty-six students (97%) completed the final examination prior to the final day of the quarter.

Table 25 presents the percentage of items included at each of levels of cognition on the exam. The number of items at each level, the mean number of correct responses to items at each level and the percentage of items correct at each level are also indicated.

Students answered more than two thirds of the items at each of the levels correctly. Eighty-three percent of the items at the interpretation level were answered correctly which was a noted improvement over the degree of performance at this level on the pretest (16% correct). Approximately
78% of the items at the knowledge, translation and analysis levels were answered correctly as well. Sixty-seven percent of the application level questions were found to be correct. The overall mean percent correct, 78%, was well above the 41% correct responses posted on the food science and nutrition pretest.

Weighted cognition scores on the final examination were calculated for each food science and nutrition student and

Table 25
Student Cognitive Performance On Food Science and Nutrition Final Examination

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Percent of Exam</th>
<th>Number</th>
<th>Mean Correct</th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>80.00</td>
<td>40</td>
<td>31.23</td>
<td>78.08</td>
</tr>
<tr>
<td>Translation</td>
<td>2.00</td>
<td>1</td>
<td>0.77</td>
<td>77.00</td>
</tr>
<tr>
<td>Interpretation</td>
<td>4.00</td>
<td>2</td>
<td>1.67</td>
<td>83.50</td>
</tr>
<tr>
<td>Application</td>
<td>4.00</td>
<td>2</td>
<td>1.34</td>
<td>67.00</td>
</tr>
<tr>
<td>Analysis</td>
<td>10.00</td>
<td>5</td>
<td>3.95</td>
<td>79.00</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.00</strong></td>
<td><strong>50</strong></td>
<td><strong>38.96</strong></td>
<td></td>
</tr>
</tbody>
</table>

n = 36
are reported in Table 26. Because of the large percentage of items on the final that were at the knowledge level of cognition (80%) and the fact that all items were of equal value, the highest possible weighted cognition score on this examination was 14.60. This maximum score was appreciably lower than those calculated for the remaining three courses considered which all had maximum weighted cognition scores on the final examination greater than 20.00

Table 26
Weighted Cognition Scores on Food Science and Nutrition Final Examination

<table>
<thead>
<tr>
<th>Score</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.01 - 7.50</td>
<td>2</td>
<td>5.56</td>
</tr>
<tr>
<td>7.51 - 9.00</td>
<td>2</td>
<td>5.56</td>
</tr>
<tr>
<td>9.01 - 10.50</td>
<td>5</td>
<td>13.89</td>
</tr>
<tr>
<td>10.51 - 12.00</td>
<td>8</td>
<td>22.27</td>
</tr>
<tr>
<td>12.01 - 13.50</td>
<td>14</td>
<td>38.89</td>
</tr>
<tr>
<td>13.51 - 15.00</td>
<td>5</td>
<td>13.89</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Possible 0.00 - 14.60

Mean 11.61

sd 1.92
Weighted cognition scores on the food science and nutrition final exam ranged from 6.60 to 14.20 with a mean of 11.61 (sd = 1.92). Forty-two percent of the students scored between 6.60 and 11.80 while 53% had scores between 12.00 and 13.60. The remaining five percent of the students scored 14.00 or higher. The mean weighted cognition score on this exam (11.61) indicated that students achieved 80% of the potential cognitive level of performance which could be evidenced by the final examination. This degree of achievement was nearly that of dairy science students (84%) but the cognitive level of the food science and nutrition final examination was considerably lower than that of the dairy science final examination (14.6 versus 22.7). It should also be noted that the mean weighted cognition score was lower on the food science and nutrition final exam (11.61) than on the food science and nutrition pretest (11.72) even though students had 37% more items correct on the posttest than on the pretest.

Horticulture

The horticulture course studied had a total enrollment of 44 students. The following sections describe characteristics of these students and the instructor as well as the cognitive levels of instruction and student performance in the class.
Student Characteristics

Forty-four individuals (100% of the class) responded to the Demographic Information Questionnaire and Motivated Strategies for Learning Questionnaire which provided the following information. Slightly more than one third (35%) of the students enrolled in the horticulture course were sophomores, 30% were juniors, 23% were freshmen and 12% were seniors. Over one half of these individuals (52.3%) were between the ages of 18 and 20. One quarter of the class was between the ages of 21 and 25 while the remaining students were between the ages of 26 and 34. Sixty-eight percent of the students were male and all were caucasian. ACT scores were collected for 82% of the horticulture students which ranged from 12 to 30 with a mean of 20.3 (sd = 4.27). This mean score was lower than that of the population (21.02).

Previous experience of students in this class exceeded that of students enrolled in the remaining three courses studied. While 55% of these students had taken no similar college courses previously, 20% had taken at least one, 20% had taken two, three or four, and five percent had taken five or more similar courses. Fifty-four percent of the group had work experience in the field of horticulture while 23% reported having two or more years of 4-H experience in the area of horticulture and 16% indicated that they had two or more years of horticulture experience through FFA activities. Nine percent reported having two or more years
of horticulture experience in high school vocational agriculture courses.

Previous experience scores in the class ranged from zero to 12 with a mean of 3.0. Seven percent of the students in the course had no horticulture experience while 41% had limited horticultural experience (scores of one or two). Students with moderate experience (scores of three, four or five) also comprised 41% of the class while those with a considerable degree of experience (scores of six to twelve) made up 11% of the group.

Motivation was an additional student characteristic considered. Responses on the MSLQ were averaged for each student to obtain a student motivation score. The possible range of scores was from 1.0 (low student motivation) to 7.0 (high student motivation). Scores for respondents in the horticulture course ranged from 3.78 to 6.55 with a mean of 5.24 (sd = .55). This mean score was slightly higher than that of the population (5.18).

Instructor Characteristics

The instructor for this horticulture course had taught this course, or a similar course, during four quarters previously and had a total of four years of university teaching experience. She had a somewhat similar course as an undergraduate and some experience in the agricultural community with issues related to the materials and concepts presented in the course. She also has some involvement in
research related to the material and concepts presented in the course. Her areas of expertise were fruit production and mycorrhizal fungi.

The instructor previous experience score calculated for the horticulture instructor was a 21 which was less than that of the dairy science and the food science and nutrition instructors (57 and 30 respectively) but greater than that of the agricultural economics instructor (17).

**Cognitive Level of Instructor Discourse**

Table 27 presents frequencies and percentages of behaviors observed in the horticulture classes at each of the seven levels of cognition included on the FTCB. While the number of behaviors identified during each observation was considerably higher during the first class period than during the second or third (91 versus 67 and 75), the percentage of behaviors occurring at each level appeared to be consistent. Forty-two percent of instructor discourse occurred at the knowledge level of cognition. An additional 19% occurred at the translation and interpretation levels. Instruction at analysis level occurred 19% of the time as well. Seven percent of instruction was at the application level while two percent took place at the synthesis level. No behaviors representing the evaluation level of cognition were observed.

The percentages reported at each level were multiplied by their respective cognitive weighting values (Table 3).
These products were totalled to give an overall cognitive level of discourse score of 21.71 for this instructor. This was the second highest such score among the four calculated. As noted earlier, these scores ranged from 20.86 to 22.08.

**Cognitive Level of Tests**

The horticulture course studied was unique in that no tests or quizzes were given during the quarter. Consequently, no data existed to report concerning the cognitive level of tests and/or quizzes.

**Table 27**

Cognitive Levels of Instructor Discourse in Horticulture Classes

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Frequencies</th>
<th></th>
<th></th>
<th></th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Obs. 1</td>
<td>Obs. 2</td>
<td>Obs. 3</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>44</td>
<td>28</td>
<td>27</td>
<td>99</td>
<td>42.49</td>
</tr>
<tr>
<td>Translation</td>
<td>7</td>
<td>9</td>
<td>12</td>
<td>28</td>
<td>12.02</td>
</tr>
<tr>
<td>Interpretation</td>
<td>18</td>
<td>10</td>
<td>12</td>
<td>40</td>
<td>17.17</td>
</tr>
<tr>
<td>Application</td>
<td>3</td>
<td>5</td>
<td>9</td>
<td>17</td>
<td>7.30</td>
</tr>
<tr>
<td>Analysis</td>
<td>19</td>
<td>13</td>
<td>13</td>
<td>45</td>
<td>19.31</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>1.72</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>91</td>
<td>67</td>
<td>75</td>
<td>233</td>
<td>100.00</td>
</tr>
</tbody>
</table>
The weighted cognition score of tests used for this course was zero. This was the lowest such score for any of the four classes studied.

**Cognitive Level of Assignments**

While students in the horticulture course did not have tests or quizzes during the quarter, the number of assignments and value given each appeared to compensate for the omission of tests, as will be evidenced shortly. Horticulture students were required to complete three types of assignments which were identified as problem solving assignments, laboratory reports and experiment reports.

Two problem solving assignments were required in the course. Each was worth 8.35% of the students' final grade. Both problem solving assignments involved students' preparing short essays which presented ideas for addressing major national and international concerns. The essays in this course dealt with global warming and the health risks associated with pesticide residues. The problem solving assignments were classified as synthesis level tasks and a weighted cognition score for these two assignments was calculated as 8.33.

The second type of assignment given in the horticulture class was the preparation of laboratory reports. Two lab reports were required and each was worth 6.7% of the students' final grade. The first lab report required students to evaluate data collected in an experiment and was
classed as an evaluation level task. The weighted cognition score calculated for the first laboratory report was 3.33. The second lab report required students to critique a journal article and was identified as an analysis level process. The weighted cognition score for the second laboratory report was 2.67.

The third type of assignment given was experiment reports. Students were required to submit two experiment reports each being worth 10% percent of their final grade. Both reports required students to prepare manuscripts comparable to a journal article which reported results of experiments conducted in the laboratory sections of the course. Both experiment reports were classified as synthesis tasks and the weighted cognition score for each report was 5.0.

The weighted cognition score for problem solving assignments (8.33), laboratory reports (6.00) and experiment reports (10.00) were totalled to provide a weighted cognition score for horticulture assignments of 24.33. This was the largest such score calculated for the four courses studied.

Totalling the weighted cognition score of tests and the weighted cognition score of assignments for the three remaining classes studied did not provide a value greater than 24.33 indicating that assignments in the horticulture class did, in effect, compensate for the lack of tests.
Student Performance on the Developing Cognitive Abilities Test

One hundred percent (44) of the students in the horticulture course completed the DCAT pretest while 95% (42 students) completed the posttest. Means reported are based upon all data collected.

Table 28 presents means and standard deviations of the percent correct at each of the levels of cognition represented on the DCAT. The horticulture class was the only one of the four studied that had higher mean scores in all three sections of the posttest than were found on the

Table 28
Horticulture Student Performance on the Developing Cognitive Abilities Test

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean % correct</td>
<td>Mean % correct</td>
</tr>
<tr>
<td></td>
<td>sd</td>
<td>sd</td>
</tr>
<tr>
<td>General cognitive abilities</td>
<td>79.14 15.90</td>
<td>81.17 13.72</td>
</tr>
<tr>
<td>Application skills</td>
<td>81.14 11.78</td>
<td>82.79 11.60</td>
</tr>
<tr>
<td>Critical thinking skills</td>
<td>63.21 17.87</td>
<td>64.88 17.11</td>
</tr>
<tr>
<td>Grand mean</td>
<td>74.50</td>
<td>76.28</td>
</tr>
<tr>
<td>n = 44</td>
<td>n = 42</td>
<td></td>
</tr>
</tbody>
</table>
pretest. On the general cognitive abilities section of the DCAT students averaged 14 correct responses to 18 items on the pretest but 15 correct responses to 18 items on the posttest. The average number of correct on the application skills section of the pretest was 14.6 of 18 but this average increased to near 15 of 18 correct on the posttest. Students had approximately 11 of 18 correct on the critical thinking skills section of the pretest and later posted an average of 11.67 of 18 correct on the same section of the posttest. The grand means indicated that the average total number of items correct increased by one from the pretest to the posttest (40 of 54 to 41 of 54).

**Horticulture Pretest**

A 55 item multiple choice subject matter pretest was administered to the horticulture students during the first week of the quarter. Items on the test represented each of the levels of cognition with the exception of the synthesis level. Ninety-eight percent (43 of 44) of the students enrolled in the class completed the pretest.

Table 29 presents the percentage of items included at each of levels of cognition on the test. The number of items at each level, the mean number of correct responses to items at each level and the percentage of items correct at each level are also indicated.

Students were able to answer between 30% and 45% of the items on the pretest correctly at the various levels of
cognition. Forty-five percent of the knowledge level questions were answered correctly and at least 40% of the questions at the interpretation and application levels were correct as well. Thirty-six percent of the evaluation level questions had appropriate responses while approximately 32% of the translation and analysis items were correct. The mean percentage of items correct on the pretest was 38.67%.

Table 29

Student Cognitive Performance On Horticulture Pretest

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Percent of Test</th>
<th>Number</th>
<th>Mean Correct</th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>29.09</td>
<td>16</td>
<td>7.25</td>
<td>45.31</td>
</tr>
<tr>
<td>Translation</td>
<td>7.27</td>
<td>4</td>
<td>1.34</td>
<td>33.50</td>
</tr>
<tr>
<td>Interpretation</td>
<td>14.55</td>
<td>8</td>
<td>3.45</td>
<td>43.13</td>
</tr>
<tr>
<td>Application</td>
<td>12.73</td>
<td>7</td>
<td>2.77</td>
<td>39.57</td>
</tr>
<tr>
<td>Analysis</td>
<td>27.27</td>
<td>15</td>
<td>4.64</td>
<td>30.93</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Evaluation</td>
<td>9.09</td>
<td>5</td>
<td>1.82</td>
<td>36.40</td>
</tr>
</tbody>
</table>

Total 100.00 55 21.27

n = 43
Weighted cognition scores were calculated for each individual by multiplying the percentage of items he/she had correct at each level of cognition by the cognitive weighting value for each level (Table 3). These products were summed to arrive at a single weighted cognition score for each student. Table 30 presents the distribution of these scores for the horticulture class.

The potential range of weighted cognition scores for the horticulture pretest was from zero to 27.28. Actual scores ranged from 5.10 to 13.73. Approximately one half

Table 30

Weighted Cognition Scores on Horticulture Pretest

<table>
<thead>
<tr>
<th>Score</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.01 - 6.50</td>
<td>1</td>
<td>2.33</td>
</tr>
<tr>
<td>6.51 - 8.00</td>
<td>9</td>
<td>20.93</td>
</tr>
<tr>
<td>8.01 - 9.50</td>
<td>13</td>
<td>30.23</td>
</tr>
<tr>
<td>9.51 - 11.00</td>
<td>6</td>
<td>13.95</td>
</tr>
<tr>
<td>11.01 - 12.50</td>
<td>10</td>
<td>23.26</td>
</tr>
<tr>
<td>12.51 - 14.00</td>
<td>4</td>
<td>9.30</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Possible range 0.00 - 27.28

Mean 9.79

sd 2.08
(51.61%) of the students scored between 6.5 and 9.5 while an additional 37% scored between 10.01 and 12.50.

The mean weighted cognition score on the horticulture pretest was 9.79 (sd = 2.08). Inasmuch as the possible score was 27.28, this mean indicated that the average class performance was approximately one third (36%) of the potential cognitive level of performance which could be evidenced by the pretest.

**Horticulture Final Examination**

A final examination consisting of 75 multiple choice items was developed by the horticulture instructor. This examination included items at the knowledge, translation, interpretation, application, and analysis levels of cognition. No items were included at the synthesis or evaluation levels. Forty-two of 44 student in the class (95%) took the final examination.

Table 31 presents the cognitive performance of students at each of the levels of cognition on the final examination. Students averaged from 55% to 85% correct responses on items at various levels of cognition included on the examination. Performance was highest at the interpretation level where 85% of all questions were answered correctly. Seventy-three percent of the items at the knowledge level were answered correctly. Approximately two thirds of the questions at the application and analysis levels were correct and 57% of the translation questions had
appropriate responses. The mean percent correct on all items on the final examination was 71% which was considerably above the mean percent correct on the pretest (39%).

Weighted cognition scores on the final examination were calculated for individual students and are reported in Table 32. Scores ranged from a 8.89 to 17.23 out of a

Table 31
Student Cognitive Performance On Horticulture Final Examination

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Percent of Exam</th>
<th>Number</th>
<th>Mean Correct</th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>63.00</td>
<td>47</td>
<td>34.33</td>
<td>73.04</td>
</tr>
<tr>
<td>Translation</td>
<td>7.00</td>
<td>5</td>
<td>2.86</td>
<td>57.20</td>
</tr>
<tr>
<td>Interpretation</td>
<td>5.00</td>
<td>4</td>
<td>3.38</td>
<td>84.50</td>
</tr>
<tr>
<td>Application</td>
<td>5.00</td>
<td>4</td>
<td>2.76</td>
<td>69.00</td>
</tr>
<tr>
<td>Analysis</td>
<td>20.00</td>
<td>15</td>
<td>9.91</td>
<td>66.07</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.00</strong></td>
<td><strong>75</strong></td>
<td><strong>53.24</strong></td>
<td></td>
</tr>
</tbody>
</table>

n = 42
possible 20.50. More than one half of the students (59.77%) scored between 10.01 and 13.00. An additional 35.71% scored between 13.01 and 16.00. The mean weighted cognition score for this class was 12.69 which indicated that students had achieved approximately 62% of the potential cognitive level of performance which could be evidenced by the final examination.

Table 32
Weighted Cognition Scores on Horticulture Final Examination

<table>
<thead>
<tr>
<th>Score</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.51 - 10.00</td>
<td>2</td>
<td>4.76</td>
</tr>
<tr>
<td>10.01 - 11.50</td>
<td>10</td>
<td>23.82</td>
</tr>
<tr>
<td>11.51 - 13.00</td>
<td>13</td>
<td>30.95</td>
</tr>
<tr>
<td>13.01 - 14.50</td>
<td>10</td>
<td>23.81</td>
</tr>
<tr>
<td>14.51 - 16.00</td>
<td>5</td>
<td>11.90</td>
</tr>
<tr>
<td>16.01 - 17.50</td>
<td>2</td>
<td>4.76</td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Possible range 0.00 - 20.50

Mean 12.69
sd 1.82
Relationships Between Selected Variables and Students' Cognitive Performance

The final two research questions guiding this study concerned possible relationships which might exist between student cognitive performance as indicated by weighted cognition scores on course final examinations and selected variables of interest. One group of variables considered included the cognitive level of course experiences (instructor discourse, tests and quizzes, and assignments). The second group of variables included student characteristics (academic ability as indicated by ACT scores, previous experience, and motivation) and instructor characteristics (previous experience). In order to assess whether such relationships existed, Pearson product moment correlations were calculated between students' weighted cognition scores and the variables indicated. Pairwise deletion of missing cases was used in making these calculations.

The description of correlations found was based upon the following convention suggested by Davis (1971).

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>.70 or higher</td>
<td>very strong relationship</td>
</tr>
<tr>
<td>.50 to .69</td>
<td>substantial relationship</td>
</tr>
<tr>
<td>.30 to .49</td>
<td>moderate relationship</td>
</tr>
<tr>
<td>.10 to .29</td>
<td>low relationship</td>
</tr>
<tr>
<td>.01 to .09</td>
<td>negligible relationship</td>
</tr>
</tbody>
</table>
The following three sections present correlations between student cognitive performance on the final examination and course experiences, student characteristics and instructor characteristics. Interpretation of correlations reported should be made with the following points in mind. Four separate, non-equivalent instruments (final exams) were used to measure student cognitive performance. Consequently, the level of cognitive performance achieved by students was dependent, to some extent, upon the cognitive levels at which each of the examinations were written. Additionally, correlations between student cognitive performance and the cognitive levels of course experiences were based upon single values representing each of the course experiences. Consequently, the correlations reported in Table 33 were computed using only four values for each course experience considered (one value per course studied).

**Course Experiences**

Correlations between students' cognitive performance on course final examinations as indicated by their weighted cognition exam score and the cognitive level of instructor discourse, tests and quizzes, and assignments is presented in Table 33.

A moderate positive relationship was indicated between student cognitive performance on the final examination and the cognitive level of tests and quizzes ($\rho = .34$). There
appeared to be a low negative relationship between student cognitive performance and the cognitive level of instructor discourse (\( \rho = -0.29 \)). The relationship existing between students' cognitive performance on the final examination and the cognitive level of assignments appeared to be negligible (\( \rho = -0.07 \)).

**Student Characteristics**

Correlations were also calculated between students' cognitive performance on the final examination and students' ACT composite scores, previous experience scores and motivation scores. Table 34 presents the correlations found between student cognitive performance and these student variables of interest.

A moderate positive relationship (\( \rho = 0.32 \)) was indicated between student cognitive performance and ACT

**Table 33**

**Correlations Between Student Cognitive Performance and Cognitive Levels of Course Experiences**

<table>
<thead>
<tr>
<th>Course Experience</th>
<th>Correlation With Students' Cognitive Achievement Score on Final Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tests and Quizzes</td>
<td>0.34 (N = 118)</td>
</tr>
<tr>
<td>Instructor Discourse</td>
<td>-0.29 (N = 118)</td>
</tr>
<tr>
<td>Assignments</td>
<td>-0.07 (N = 118)</td>
</tr>
</tbody>
</table>
composite score. While a low positive relationship appeared to exist between student motivation and cognitive performance ($\rho = .12$). The relationship between student previous experience and cognitive performance appeared to be negligible ($\rho = .03$).

**Instructor Characteristics**

The final correlation calculated was between student cognitive performance on the final examination and the instructor previous experience scores which served as an interval measure of the instructors' background in the course content. The correlation coefficient obtained for this pair of variables was $0.38$ ($N = 118$) indicating a moderate positive relationship between instructor experience and student cognitive performance.

**Table 34**

Correlations Between Student Cognitive Performance and Selected Student Characteristics

<table>
<thead>
<tr>
<th>Student Characteristic</th>
<th>Correlation With Students' Cognitive Achievement Score on Final Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT Composite Score</td>
<td>0.32 ($N = 99$)</td>
</tr>
<tr>
<td>Motivation</td>
<td>0.12 ($N = 93$)</td>
</tr>
<tr>
<td>Previous Experience</td>
<td>0.03 ($N = 100$)</td>
</tr>
</tbody>
</table>
Moderate, low or negligible correlations found between all variables of interest and student cognitive performance in the subject matter area indicated that no clear associations appeared to exist between variables considered in this study and student cognitive performance. It was clear, however, that a marked improvement in student cognitive performance in the subject matter areas did occur in the agricultural economics, dairy science and horticulture courses as evidenced by the differences in weighted cognitive achievement scores on the pretest and posttest. It appears that similar results would have held true for the food science and nutrition course had the final examination included more items written at levels other than the knowledge level of cognition.
CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to describe the cognitive level of course experiences and student performance in four Ohio State University College of Agriculture courses. This study also investigated relationships between students' cognitive performance and the cognitive levels of course experiences. Student cognitive performance was assessed using the course final examination. Course experiences considered included the cognitive levels of instructor discourse, tests and quizzes, and assignments.

The following research questions were developed to guide the study.

1. What was the ability of students at the various levels of cognition upon entering selected courses in the Ohio State University College of Agriculture?

2. What was the ability of students at the various levels of cognition upon completion of selected courses in the Ohio State University College of Agriculture?
3. What were the cognitive levels of instructor discourse, tests and quizzes, and assignments in selected courses in the Ohio State University College of Agriculture?

4. To what extent did relationships exist between the cognitive level of course experiences (instructor discourse, tests and quizzes, assignments) and students' cognitive performance?

5. To what extent did relationships exist between additional selected variables and students' cognitive performance? Additional variables considered included:
   a. student academic ability as indicated by ACT scores,
   b. student prior experience with course content through work experience, high school courses and high school activities,
   c. student motivation, and
   d. instructor previous experience.

**Research Design**

This study was descriptive in nature, requiring that a wide variety of data be collected in order to present a detailed explanation of each of the variables of interest in each of the courses. This was done in order to facilitate replication of the study and critical analysis of results.
Population and Sample

The population for this study was 127 students enrolled in four selected introductory level courses in the Ohio State University College of Agriculture during Spring Quarter, 1989. Students in these courses comprised experimentally accessible intact groups.

The courses involved in the study were identified as being among the 23 courses offered in the College of Agriculture during Spring Quarter, 1988 which had either 100 or 200 level course numbers. One instructor in each of five disciplines represented in the College of Agriculture was selected to take part in the study based upon their willingness to assist in the efforts to improve instruction in the college. Instructors agreeing to take part in the study taught courses in agricultural economics, agricultural mechanization, dairy science, food science and nutrition, and horticulture. An extensive amount of missing student data resulted in the elimination of the agricultural mechanization course from the study.

Instrumentation and Data Collection

The nature of the variables considered required the use of several instruments. A summary of each of the instruments used and the manner in which it was administered and interpreted follows.
Cognitive Level of Instructor Discourse. The cognitive level of instructor discourse was assessed using the Florida Taxonomy of Cognitive Behavior (FTCB) (Appendix B). This instrument is based upon Bloom’s Taxonomy and is designed to identify specific cognitive behaviors of teachers or students.

Validity of the FTCB is based upon its’ direct development from Bloom’s Taxonomy and the support generally given Bloom et al.’s hierarchy for the classification of cognitive behaviors. Reliability of the instrument is dependent upon the raters’ utilization of the instrument and in this study a Spearman correlation coefficient of .99 was calculated as the raters’ degree of reliability in use of the FTCB.

Three class sessions in each of the courses in the study were observed and audio recorded during the quarter. Observation notes were recorded during the class period (Appendix C) and actual classification of behaviors observed using the FTCB took place following each class. Audio recordings and notes taken during class served as evidence of behaviors recorded by the rater.

Weighted discourse scores at each of the levels of cognition were determined by multiplying the percentage of behaviors observed at each level by a weighting value for that level (Table 3). These products were summed to give a cognitive level of discourse score for each instructor.
Cognitive Levels of Tests, Quizzes and Assignments.

The cognitive levels of tests, quizzes and assignments were also assessed using the Florida Taxonomy of Cognitive Behavior. Each item on all tests, quizzes and assignments given in each of the four courses was classified by the rater using the categories specified on the FTCB. A score representing the cognitive level of each test, quiz or assignment was determined by multiplying the percentage of items appearing at each level of cognition by their respective cognitive weighting values and summing these products.

Student Cognitive Performance Upon Entering Course.

The cognitive performance of students upon entering courses was evaluated using two instruments, the Developing Cognitive Abilities Test and a subject matter pretest. Specifics concerning each are as follows.

The Developing Cognitive Abilities Test assessed student cognitive performance at three levels - general cognitive abilities (knowledge and comprehension), application skills, and critical thinking skills (analysis, synthesis and evaluation). The Level L (grade 12) form of the test was used and students completed the verbal and quantitative sections of the test. Validity of the instrument was established by the developers (Beggs, 1988) but ceiling effect in the general cognitive abilities and applications skills section of the test was noted as a
validity concern in this study. Reliability of the DCAT in this study was indicated by Kuder-Richardson 20 coefficients was .65 for the general cognitive abilities items, .59 for the application skills items, and .72 for the critical thinking skills items.

A subject matter specific pretest was developed by the researchers for each course studied using previous quarter final examinations for the course. Items were included at all levels of cognition with the exception of the synthesis level. Course instructors and researchers in the area of cognition reviewed the pretests to assess their validity. Reliability was determined using pretests completed in the study and Kuder-Richardson 20 coefficients for each pretest were .66 for agricultural economics, .70 for dairy science, .45 for horticulture and .19 for food science and nutrition. The subject matter pretest and the DCAT were administered in class during the first week of the quarter.

For each student, a weighted score at each of the levels of cognition on the pretest was determined by multiplying the percentage of items correct at each level of cognition by the weighting value for that level (Table 3). These products were summed to give individual student cognitive performance score on the pretest.

**Student Cognitive Performance Upon Completion of the Course.** Two instruments were used to assess student cognitive performance upon completion of the course. These
were the Developing Cognitive Abilities Test and course final examination.

The identical version of the DCAT administered at the beginning of the quarter was given again in class during the final week of the quarter. Test sensitization was not found to be validity threat in using the identical instrument as indicated by similar mean scores and standard deviations on the pretest and posttest.

The course final examination was used as the subject matter posttest for each course. Items on the final examination were classified using the FTCB and a weighting value was assigned to each item based upon its' level of cognition (Table 3). Each item was also weighted according to the proportion of the total grade value assigned the item by the instructor. These weighting values were multiplied and the products summed to provide individual student cognitive performance scores on the final examination.

Student Motivation. Student motivation was assessed using the Motivated Strategies for Learning Questionnaire (MSLQ) (Appendix D). Students responded to 40 statements concerning motivation on a seven point Likert-type scale. Developers of the MSLQ had established validity of the instrument and the degree of reliability of the MSLQ in this study was represented by a Cronbach's alpha coefficient of .85. The instrument was completed by students outside of class during the first week of the quarter.
Student Academic Ability. ACT scores were used as an indicator of student academic ability. Scores were obtained from university academic records.

Student Previous Experience. Student previous experience was evaluated using a questionnaire developed by Straquedine in 1987. Validity was established by a panel of teacher educators and researchers and reliability of the student previous experience questions was reported as a Cronbach's Alpha of .70. Items from the original questionnaire appeared as a section of the Demographic Information Questionnaire used in this study (Appendix E). This questionnaire was completed by students outside of class during the first week of the quarter.

Instructor Characteristics. An instrument developed and used by Pickford (1988) was used to collect information concerning instructor's previous experience (Appendix F). Validity of the instrument was established by a panel of experts but no indication of the instrument's reliability have been reported.

Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences PC version (SPSS-PC+). Each student represented one case in the data set. Data were analyzed by individual courses as well as for the population.
Frequency distributions were generated for each of the variables considered in order to provide a description of the nature of the variable in each group as well as in the population. Additionally, Pearson product moment correlations were calculated between the cognitive level of performance on the course final examination and the cognitive levels of discourse, quizzes and tests, and assignments. Correlations were also calculated between student cognitive performance and student motivation, student academic ability, student previous experience, and instructor previous experience.

Summary of Findings

Population Characteristics

Demographic information describing students included in the study was collected from 108 individuals, or 85% of the population. The following information was provided by these respondents.

The majority of students in these introductory level courses were juniors or seniors (53%). Twenty-seven percent were sophomores and 20% were freshmen. Approximately two thirds of the population (67.6%) were between the ages of 19 and 22. Individuals 18 years of age represented six percent of the population while the remainder of the students were between 23 and 34 years of age. Sixty-one percent of the
students were male, 39% were female, and 98% of the population were caucasian.

Students enrolled in the courses studied had limited previous experience with the course content. Sixty percent of the population had taken no college courses which were similar to the course involved in the study. Twenty percent had taken one comparable course. Fewer than 40% of the students in the population had work experience in the subject matter area while less than 30% had any appreciable degree of experience in high school high school activities or courses related to the course in which they were enrolled.

ACT composite scores were secured for 83.5% of the population. Those scores collected had a mean of 21.02 (sd = 4.5) and scores ranged from 11 to 33.

Agricultural Economics Course Characteristics

The agricultural economics course had a total enrollment of 25 students. The following information concerning the characteristics and performance of these students as well as other course characteristics considered was found.

Student Characteristics. Fourteen individuals (56%) responded to the Demographic Information Questionnaire which provided information concerning student characteristics. Approximately 50% of the agricultural economics students
responding were either juniors or seniors and 43% were freshmen. Two thirds (66.7%) of these individuals were male. ACT scores were secured for 80% of the agricultural economics students. The mean ACT score of students in this class was 20.8 (sd = 3.7) which was slightly lower than the population mean.

Over fifty percent (57%) of those individuals enrolled in the agricultural economics class had taken at least one other college economics course previously but over 80% had no previous work experience or experience through high school activities dealing with agricultural economics. Twenty-one percent indicated that they had taken high school courses that focused upon economic principles. Previous experience scores for the class ranged from zero to seven with a mean of 3.0 (sd = 2.65).

Motivation scores in the agricultural economics course ranged 4.68 to 5.58 on a scale of 1.0 to 7.0. Lower scores indicated a lower degree of motivation. The mean motivation score in this class was 5.0 (sd = .26) which was slightly lower than similar means calculated for the remaining three courses.

**Instructor characteristics.** The agricultural economics course instructor had the least amount of previous experience of the four instructors included in the study. She had a total of ten years of professional experience in the field of agricultural economics.
Cognitive Level of Instructor Discourse. The greatest percentage of teacher discourse at any one level occurred at the knowledge level of cognition (34.6%). Translation behaviors comprised 23.3% of the agricultural economics instructor discourse. Less than six percent of instruction occurred at the application and evaluation levels and no behaviors at the synthesis level of cognition were observed.

The cognitive level of discourse score for this instructor was 22.08. This was the highest such score calculated. The remaining discourse scores ranged from 20.86 to 21.71.

Cognitive Levels of Tests. Students in agricultural economics were given three tests during the quarter prior to the final examination. Each was worth 16.67% of the students' final grade. Nearly one half (48.7%) of the items on these tests were knowledge level questions. Analysis was required for approximately 16% of the items while questions at the translation, interpretation, application and evaluation levels each comprised from seven to eleven percent of the tests. Only one synthesis level question appeared on any of the tests.

A cognitive score for tests in the agricultural economics course was 12.23 which was the highest such value obtained in any of the courses studied. Similar values in other courses ranged from zero to 9.20.
Cognitive Level of Assignments. Five homework assignments were given in the agricultural economics course which comprised 20% of the students' total grade. Approximately 40% of all assignment items were written at the application level while 13% to 17% of the items were at the knowledge, translation, interpretation and analysis levels each. Five percent of the assignment questions were at the evaluation level. No synthesis level questions appeared on the assignments.

The total weighted cognition score for agricultural economics assignments was 5.25 which was among the two lowest such scores calculated in the courses studied. Other course assignment scores ranged from 3.80 to 24.33.

Student Performance on the Developing Cognitive Abilities Test. Student performance on the DCAT varied at each of the levels between the pretest and posttest. A marked decline in performance at the general cognitive abilities level occurred between the pretest and the posttest as indicated by means of 79.87% correct on the pretest versus 73.50% correct on the posttest. Performance on application skills items declined also, but to a lesser degree (80.44% versus 78.14%). Performance on the critical thinking skills section of the test improved from a mean of 55.57% correct on the pretest to a mean of 61.43% correct on the posttest.
Agricultural Economics Pretest. A 54 item agricultural economics pretest which included items at all levels of cognition (with the acceptance of the synthesis level) was given during the first week of the quarter. Students were able to correctly answer approximately one half of the knowledge level questions and slightly more than one third of the interpretation and application level questions. They averaged one third or less correct responses at the translation, analysis and evaluation levels. The mean percentage of items correct for the entire test was 36.6% which was the lowest such average for any of the courses studied.

Weighted cognition scores were calculated for each student completing the pretest. The potential range of scores was from zero to 28.9 and actual weighted cognition scores ranged from 3.7 to 15.2. The mean weighted cognition score for the class was 9.9 (sd = 2.8) which indicated that the average class performance was approximately one third (34%) of the potential cognitive level of performance which could be evidenced by the pretest.

Agricultural Economics Final Examination. A 50 item final examination was developed by the instructor which included items at all levels of cognition with the exception of the synthesis level. Students answered more than 50% of the items correctly at each of the levels of cognition. Performance was highest at the translation and application
levels where more than 70% of the items were answered correctly. Students also averaged more than 60% correct at the knowledge and application levels and approximately 50% correct at the interpretation and analysis levels. The mean percent correct on all items on the final examination was 61%.

Weighted cognition scores on the agricultural economics final examination ranged from 10.2 to 23.8 out of a possible 28.0. The mean cognition score for the course was 16.86 (sd = 3.0) which indicated that students had achieved 60% of the potential cognitive level of performance which could be evidenced by the agricultural economics final examination.

Dairy Science Course Characteristics

The dairy science course studied had a total enrollment of 21 students. The following information was found regarding student and course characteristics considered.

Student Characteristics. Nineteen individuals (91% of the class) responded to the Demographic Information Questionnaire which indicated the following. Fifty-three percent of the students in the dairy science course were seniors and 26% were juniors. The remainder of the students in the class were equally divided between freshman and sophomore class ranks. The average age of students in the course was 22 and ages reported ranged from 18 to 28. Sixty-eight percent of the students were female. The ACT
scores of students in the class ranged from 16 to 33 with a mean of 22.9 (sd = 5.0). This mean was nearly two points higher than that of the population.

Previous experience of students in the dairy science course was largely centered around work experience and high school activities. Forty-two percent of these students had some previous work experience in the dairy industry and a similar percentage had two or more years of 4-H experience in dairy-related projects. Thirty-seven percent had two or more years of vocational agriculture and FFA experience in the subject matter area. Twenty-one percent had taken similar college courses previously. Previous experience scores in this course ranged from zero to seven with a mean of 2.74 (sd = 2.0). Only one student in the course had no previous dairy science experience.

Motivation scores in the course ranged from 4.53 to 6.15 (out of a possible 7.0) with a mean of 5.25 (sd = .41). This mean score was above that of the population (5.18) as well as similar mean scores calculated for the remaining courses included in the study.

Instructor Characteristics. The instructor of the dairy science class had, by far, the most extensive previous experience in the course content of all instructors studied. He had a total of 31 years of university teaching experience and had taught similar courses 21 quarters or semesters previously. He also authored the text used in the course.
The instructors previous experience score for this individual was 57 which was nearly double that of the next highest such score found (30).

**Cognitive Level of Instructor Discourse.** Over one half of the instructor behaviors observed in the dairy science class were at the knowledge and translation levels of cognition (38.8% and 17.6% respectively). Nearly 23% of the instructor discourse was at the interpretation level while 20% was at the application and analysis levels. No teacher discourse was observed at the synthesis level and less than one percent was devoted to evaluation. The cognitive level of discourse score for this instructor was 20.86 which was the lowest such score among the four calculated.

**Cognitive Level of Tests.** Students in the dairy science course studied were given two tests and a total of six quizzes during the quarter. Sixty-three percent of the value of the dairy science tests and quizzes was devoted to items at the knowledge level of cognition. An additional 21% were at the interpretation level. Items requiring application comprised less than 10% of the tests and quizzes values and translation, analysis and evaluation items combined made up less than 10% of the tests and quizzes. No synthesis level questions appeared on any dairy science test or quiz. The weighted cognition score for dairy science tests and quizzes was 8.61 which was the lowest such score among the three courses that included tests and/or quizzes.
Cognitive Levels of Assignments. Students in the dairy science class were expected to complete two types of assignments during the quarter. One type of assignment was the completion of periodic laboratory exercises which represented 10% of the students' final grade. These exercises required 50% application level tasks and 50% evaluation level tasks. The second type of assignment involved the option of reviewing three professional journal articles or completing a term paper. Either assignment contributed 20% to the students' final grade. Those students reviewing journal articles were expected to be operate at the evaluation level of cognition while those prepared a term paper operated at the synthesis level.

The total weighted cognition score for dairy science assignments was 14.0 which was the second highest value among the four such scores calculated. Assignments weighted cognition scores ranged from 3.88 to 24.33 in the courses studied.

Student Performance on the Developing Cognitive Abilities Test. Dairy science students performed similarly on the pretest and posttest administration of the DCAT. The mean percentage correct on the general cognitive abilities section and application skills section was between 84% and 86% on both tests. The mean percentage correct on the critical thinking skills section of both tests was approximately 66.5%. The overall percentage of items
correct on both tests was approximately 71.5%. Dairy science students consistently averaged from three to four percent higher on each of the sections of the pretest and posttest than the population. No other class consistently scored above the population means on the DCAT.

**Dairy Science Pretest.** Students were able to answer slightly more than one half of all items on the dairy science pretest correctly. The percentage of items answered correctly at each of the levels of cognition varied from 45% at the application level to 64% at the evaluation level indicating that students were fairly consistent at answering items correctly at all levels of cognition appearing in the pretest. The mean percentage correct on the dairy science pretest was well above similar values determined for other course pretests (40.92, 38.67 and 36.59).

Weighted cognition scores on the dairy science pretest ranged from 8.30 to 19.50 out of a possible 27.00. The mean weighted pretest cognition score for the course was 14.05 (sd = 3.23) which indicated that the students' cognitive performance was 52% of the potential cognitive level of performance which could be evidenced by the pretest. No other group of students approached this level of performance on the subject matter pretest.

**Dairy Science Final Examination.** The dairy science final examination included items at the knowledge, interpretation, application, analysis and synthesis levels
of cognition. All students answered the single synthesis level item correctly and had more than 80% of the items at the application and analysis levels correct. Three fourths (75%) of the knowledge level questions were answered correctly while approximately 63% of the interpretation level questions were correct. The mean percentage of items correct on the dairy science final was 78.6% which was greater than similar percentages found in other courses studied.

Weighted cognition scores on the dairy science final examination ranged from 15.2 to 21.7 out of a possible 22.7. The mean weighted cognition score for this group of students was 19.1 (sd = 1.65) which indicated that students had achieved 84% of the potential cognitive level of performance which could be evidenced by the final examination.

**Food Science and Nutrition Course Characteristics**

The food science and nutrition course studied had a total enrollment of 37 students. The following was found regarding the characteristics and performance of these students as well as additional course characteristics of interest.

**Student Characteristics.** Eighty-four percent of the food science and nutrition students responded to the Demographic Information Questionnaire. Forty-five percent
of the students in the course were seniors, 35% were sophomores, 10% were freshmen and 10% were juniors. Approximately two thirds of these students were between the ages of 18 and 21. The ages of the remainder of the class ranged from 22 to 29. Sixty-five percent of the students were male. ACT scores of students in the course ranged from 11 to 28 with a mean of 20.9 (sd = 4.7).

Previous experience of the students enrolled in the food science and nutrition course was limited in comparison to the population. Sixty-five percent of the students had taken no similar college courses and over 80% had no previous work experience in the field of food science. Less than 40% of the students had any appreciable degree of exposure to food science and nutrition concepts during high school. Previous experience scores in the course ranged from zero to eight with a mean of 2.30. Seventy-one percent of the students in this course had scores of either zero, one or two.

Motivation scores for the respondents in the food science and nutrition course ranged from 3.68 to 6.10 with a mean of 5.14 (sd = .55). This mean score was comparable with that of the population (5.18).

Instructor Characteristics. The instructor for this course had taught this same course or a similar course during 16 previous quarters and had a total of 14 years of university teaching experience but had limited experience
with the course content and materials beyond this. The instructor previous experience score calculated for this individual was 30 which was second to the highest such score (57) and greater than the remaining two instructor experience scores calculated (21 and 17).

**Cognitive Level of Instructor Discourse.** A greater percentage of time (45.3%) was devoted to instruction at the knowledge level of cognition in this course than in others studied. Approximately 23% of the food science and nutrition discourse occurred at the translation and interpretation levels while 21% occurred at the analysis level and only one behavior was observed at the synthesis level. No behaviors were observed at the evaluation level. The score representing the cognitive level of discourse for this instructor was 21.63. Other cognitive discourse scores ranged from 20.86 to 22.08.

**Cognitive Levels of Tests.** Food science and nutrition students were given two test during the quarter. Each test was worth 25% of the students' final grade. Seventy percent of the items appearing in these tests were written at the knowledge level of cognition. Analysis was required on 15.5% of the items while synthesis and translation were required to correctly answer less than eight percent of the test questions. Two questions (1.0%) were written at the interpretation level and no application or evaluation level questions appeared on the tests. The weighted cognitive
value for the two tests was 9.20 which was the second highest of the four such values obtained in the study. Weighted cognition scores for tests ranged from zero to 12.23.

**Cognitive Level of Assignments.** Food science and nutrition students were expected to complete three assignments. The first assignment was the development of a personal food chart. This assignment was worth 6.25% of the students' final grade and required students to operate at the application level of cognition. The second assignment was the development of a proposed dietary intake schedule. This assignment was worth 3.75% of the students' final grade and it required synthesis level thought. The final assignment was the completion of discussion section questions. This assignment was worth 10% of the students' final grade and all discussion section questions completed required knowledge level thought.

The total weighted cognition score for the three assignments was 3.80 which was the lowest such value found among the four courses studied.

**Student Performance on the Developing Cognitive Abilities Test.** Students in the food science and nutrition classes performed less well on the DCAT posttest than on the DCAT pretest. While the mean percentage of items correct on the general cognitive abilities section of the test increased slightly from the pretest to the posttest (77.97%
to 78.27%) the mean score on the remaining two sections of the test decreased appreciably on the posttest. The mean percentage correct on the application skills section of the test fell from 80.79% on the pretest to 78.16% on the posttest while average percent correct in the critical thinking section dropped from 62.08% on the pretest to 60.52% on the posttest. The overall percentage correct fell from 73.61% to 72.32%. Mean percentages correct in this course were slightly higher than those of agricultural economics students by lower than those of horticulture and dairy science students.

**Food Science and Nutrition Pretest.** Students were able to answer approximately one half to the application and analysis level questions correctly on the food science and nutrition pretest and 40% of the knowledge and evaluation level questions correctly. Food science students were also able to answer one of three translation level questions correctly but averaged less than one correct answer for each five interpretation level questions. The mean percent correct for the entire test was 41% which was higher than similar scores found in the agricultural economics and horticulture courses (37% and 39% respectively) but lower than the percent correct on the dairy science pretest (52%).

The weighted cognition scores on the food science and nutrition pretest ranged from 7.16 to 18.49 out of a possible 27.87. The mean weighted cognition score was 11.72
which indicated that students in this course performed at 42% of the potential cognitive level of performance that could be evidenced by the pretest.

Food Science and Nutrition Final Examination. Eighty percent of the items on the food science and nutrition final examination were written at the knowledge level of cognition. Other levels represented on the exam included translation, interpretation, application and analysis. No items at the synthesis or evaluation levels of cognition appeared on the food science final examination.

Student answered more than two thirds of the items at each of the levels of cognition correctly. Eighty-three percent of the interpretation items were answered correctly while approximately 78% of items at the knowledge, translation and analysis levels were correct. Sixty-seven percent of the interpretation level questions had appropriate responses. The overall mean percentage correct was 78%.

Weighted cognition scores on the final examination ranged from 6.6 to 14.2 out of a possible 14.6. The mean weighted cognition score was 11.6 (sd = 1.92) which indicated that students achieved 80% of the potential cognitive level of performance which could be evidenced by the final examination.

The mean weighted cognition score for the food science class was found to be lower on the final examination than on
the subject matter pretest even though students nearly
doubled the percentage of items answered correctly from the
pretest to the final exam. The unusually high percentage of
knowledge level questions on the final examination appeared
to be the reason for this occurrence.

**Horticulture Course Characteristics**

The horticulture course studied had a total enrollment
of 44 students. The following information regarding the the
students, instructor, and course characteristics of interest
was found.

**Student Characteristics.** All individuals in the class
responded to the Demographic Information Questionnaire which
provided the following information. Thirty-five percent of
the students enrolled in the horticulture course were
sophomores, 30% were juniors, 23% were freshmen and 10% were
seniors. Over one half of these individuals were between
the ages of 18 and 20, one quarter were between the ages of
21 and 25 and the remaining students were between 26 and 34
years of age. Sixty-eight percent of the students were
male. ACT scores of these students ranged from 12 to 30
with a mean of 20.3 (sd = 4.27).

Forty-five percent of the students enrolled in the
horticulture course had taken one or more similar college
courses previously. Fifty-four percent of the group had
work experience in the field of horticulture but fewer than
25% reported having obtained an appreciable degree of horticultural experience in high school courses and activities. Previous experience scores in this class ranged from zero to 12 with a mean of 3.0 (sd = 2.4).

Motivation scores in the horticulture class ranged from 3.78 to 6.55 (out of a possible 7.0) with a mean of 5.24 (sd = .55). This mean score was slightly higher than that of the population (5.18).

**Instructor Characteristics.** The instructor for this course had taught the same or a similar course during four quarters previously and had a total of four years of university teaching experience. She also had ten years of professional experience in production horticulture and had been involved in similar courses as an undergraduate and graduate student. The instructor previous experience score for this professor was 21 which above the lowest such score reported (17) but below that of the two remaining instructor previous experience scores (30 and 57).

**Cognitive Level of Instructor Discourse.** Forty-two percent of the instructor discourse occurred at the knowledge level of cognition. An additional 29% occurred at the translation and interpretation levels. Instruction at the analysis level occurred 19% of the time while seven percent of the instruction was at the application level and two percent was at the synthesis level. No behaviors at the evaluation level were observed in the horticulture classes.
The cognitive level of discourse score for this instructor was 21.71 which was the second highest of the four such scores calculated.

Cognitive Level of Tests. No tests or quizzes were given in the horticulture course during the quarter. The score representing the cognitive level of tests for this course was zero.

Cognitive Level of Assignments. Horticulture students were required to complete three types of assignments identified as problem solving assignments, laboratory reports and experiment reports. Two problem solving assignments were given in the course which required students to write short essays on national and international concerns and were therefore classified as synthesis level tasks. The weighted cognition score for these problem solving assignments was 8.33.

The second type of assignments given were laboratory reports. Two such reports were required. One involved the reporting of an experiment which was an evaluation level task. The second involved critiquing a professional journal article which was considered an analysis level project. The weighted cognition scores for laboratory reports was 6.0.

The third type of assignments given in the horticulture course were experiment reports. Two experiment reports were required and both were classified as synthesis level tasks.
The weighted cognition score of the two experiment reports was 10.0.

The total weighted cognition score for assignments in the horticulture course was 24.33. This was the largest such score calculated among the four courses.

Student Performance on the Developing Cognitive Abilities Test. Horticulture students had higher average scores on all sections of the posttest than they had on the pretest. In the general cognitive abilities section the mean percent correct increased from 74.14% on the pretest to 81.17% on the posttest. In the application skills section the increase was from 81.14% correct on the pretest to 82.79% correct on the posttest. Mean percentages correct in the critical thinking skills section increased from 63.21% on the pretest to 64.88% on the posttest. The overall percent correct increased from 74.50% to 76.28%. No other group of students consistently scored higher on all sections of the posttest.

Horticulture Pretest. Students were able to answer between 30% and 45% of the items on the pretest correctly at the various levels of cognition. Forty-five percent of the knowledge level questions were answered correctly and at least 40% of the interpretation and application questions had appropriate responses. Approximately 32% of the translation and analysis items were correct. The mean percentage of items correct was 38.67%. Weighted cognition
scores on the horticulture pretest ranged from 5.10 to 13.73 out of a possible 27.28. The mean weighted cognition score was 9.79 (sd = 2.08) which indicated that the average class performance was 36% of the potential cognitive level of performance which could be evidenced by the pretest.

**Horticulture Final Examination.** The horticulture final examination included questions at the levels of cognition up to, and including, the analysis level. Synthesis and evaluation level items did not appear on the examination. Student performance was highest at the interpretation level where 85% of all questions were answered correctly. Seventy-three percent of the items at the knowledge level had appropriate responses while approximately 67% of the application and analysis level questions were correct. Fifty-seven percent of the translation items had appropriate responses. The mean percent correct on the final exam was 71%.

Weighted cognition scores on the horticulture final examination ranged from 8.89 to 17.23 out of a possible 20.50. The mean weighted cognition score for this group of students was 12.69 (sd = 1.62) which indicated that students had achieved 62% of the potential cognitive level of performance which could be evidenced by the final examination.
Relationship Between Selected Variables and Students' Cognitive Performance

Pearson product moment correlations were calculated between students' weighted cognition score on the final examination and the major variables of interest in the study. These variables included the cognitive level of instructor discourse, the cognitive level of tests and quizzes, the cognitive level of assignments, student academic ability (indicated by ACT score), student previous experience, student motivation, and instructor previous experience. Interpretation of the correlations obtained should be made with the knowledge that the instruments used to measure student cognitive performance (final examinations) were non-equivalent.

There appeared to be moderate positive correlations between student cognitive performance on the course final examinations and three variables of interest. These were the cognitive level of tests and quizzes ($\rho = .34$), the degree of instructor previous experience ($\rho = .38$), and students' ACT composite scores ($\rho = .32$). A low positive relationship was indicated between student cognitive performance and student motivation ($\rho = .12$) while a low negative relationship appeared to exist between student cognitive performance and the cognitive level of instructor discourse ($\rho = -.29$). The association between student cognitive performance and student previous experience as
well as the cognitive levels of course assignments appeared to be negligible ($\rho = .03$ and $\rho = -.07$ respectively).

**Conclusions and Implications**

The following conclusions and implications are based upon interpretation of the results of this study.

**Conclusion 1.** Instructor discourse in the courses studied occurred primarily at the lower levels of cognition. All instructors taught at the knowledge level more frequently than at any of the remaining levels. Additionally, little or no instructor discourse among the four individuals studied was at the synthesis or evaluation levels of cognition.

**Implication 1.** If the hierarchical nature of Bloom's Taxonomy is accepted as a model for the consideration of the cognitive processes associated with teaching and learning the large percentage of time devoted to the presentation of facts by instructors may be justified. Without facts, thinking at the higher levels of cognition cannot occur. However, if the instructor expects students to be able to apply, analyze, synthesize or evaluate information, it appears that the thought processes associated with functioning at these levels of cognition should be demonstrated to some extent by the instructor. Students in courses studied were provided such examples of thought at the application and analysis levels of cognition but were
given virtually no demonstrations of thought associated with the synthesis and evaluation of information in each of the subject matter areas.

**Conclusion 2.** The cognitive level of performance expected by instructors on tests and quizzes was comparable to the instructors' cognitive level of discourse. Among the three instructors giving tests and/or quizzes, rankings were similar with regard to cognitive level of discourse and cognitive level of tests and quizzes. Instructors who taught at higher levels of cognition expected a higher degree of cognitive performance by students in their class.

**Implication 2.** Instructors that teach and test at higher levels of cognition allow their students more opportunities to perform at higher levels of cognition than those who do not. If the objective of the instructor is to have students do more than merely recall, restate or interpret facts, devoting more attention to discourse and testing at the higher levels of cognition may be appropriate, if not necessary.

**Conclusion 3.** Assignments given by instructors in this study were, as a whole, designed to assess student performance at higher levels of cognition than were tests or quizzes given. A similar conclusion was reached by Pickford (1988) and Newcomb and Trefz (1987). The percentage of students' final grades determined by assignments varied considerably among the courses studied however.
Implication 3. In the classes studied, assignments were used less as a means of restating facts. Rather, they were used to encourage students to apply, analyze, synthesize and evaluate information in the subject matter areas. The potential effectiveness of these assignments may be assessed, in part, by the percentage of students' final grades allocated to assignments by instructors. Assignments worth little on a students' final grade are likely to receive less attention than those worth a considerable proportion of the final grade. Consequently, even though assignments provided students an opportunity to perform at higher levels of cognition, they may have elicited only limited or superficial higher order cognitive behaviors by students in some instances because of the relative lack of importance of the assignment.

Conclusion 4. Cognitive performance of students in the subject matter areas improved between the beginning and completion of the courses studied.

Implication 4. While it is unclear whether a single course impacts upon a students' innate ability to apply, analyze, synthesize or evaluate information, it does appear to impact upon students' ability to carry out these thought processes in dealing with specific subjects. While it is the role of the instructor to provide facts in order to establish a knowledge base for higher order cognitive performance by students, it may also be necessary to the
instructor to demonstrate, and provide opportunities to exhibit, behaviors reflecting thought at the higher levels of cognition.

**Conclusion 5.** None of the variables which were considered (course experiences, student characteristics, instructor characteristics) appeared to be clearly associated with student cognitive performance in subject matter areas.

**Implication 5.** Further research is needed in order to determine which, if any, factors impact upon the cognitive performance of students in subject matter areas. While it is clear that students are performing at higher levels of cognition in the subject matter areas at the completion of the course than at the beginning of the course, it is uncertain what factor, or factors, is most influential in bringing about this change in performance.

**Discussion**

The preceding conclusions indicated that no single factor, or group of factors, considered in this study appeared to be clearly responsible for improving students' cognitive performance. Limited variance in a number of variables considered and the possible interaction of two or more of the variables studied appear to be likely explanations for the inability to conclusively state that specific variables are directly associated with student
cognitive performance. Failure to identify such relationships does not warrant the limitation of further critical analysis of the findings of this study however. The discussion section presents a critical analysis by the researcher of the findings reported.

Cognitive Levels of Course Experiences

It was apparent in this study that instructors' cognitive level of discourse did not vary greatly. Weighted cognition scores for instructor discourse were similar among the four professors included in the study and their range encompassed the three instructor discourse scores reported by Pickford (1988). This finding provides further evidence that discourse in College of Agriculture courses is taking place primarily at the lower levels of cognition. Consequently, students' opportunities to observe demonstrations of the thought processes associated with operating at the higher levels of cognition are limited.

In this study, as in Pickford's, it was also clear that tests are being written to reflect the cognitive levels of instructor discourse occurring in courses. The vast majority of test items in both studies were found to be written at the knowledge, comprehension and application levels of cognition.

Why instructors are focusing upon student assessment at the lower levels of cognition is uncertain. Perhaps instructors are either consciously or unconsciously writing
test items that reflect their cognitive level of discourse. Perhaps instructors are attempting to avoid giving students "harder" questions which may require thought at the analysis, synthesis and evaluation levels of cognition. Instructors may not be accustomed to writing or evaluating items which require students to perform at higher levels of cognition as well. Whatever the reason might be, students had limited opportunities to practice and demonstrate the analysis, synthesis and evaluation of information in completing course tests.

A third similarity noted between the findings of this study those of Pickford was that the cognitive levels of items or tasks included in assignments were typically higher than the cognitive levels of instructor discourse in the courses studied. Assignments were more likely to require students to apply, analyze, synthesize or evaluate information than were tests. Consequently, assignments allowed students the opportunity to practice and demonstrate thought at the higher levels of cognition. Student performance on assignments was not typically valued as highly by instructors as performance on tests and examinations however, as indicated by the relative low proportion of students' total grades allocated to assignments. It appears that placing greater emphasis upon course assignments may be one simple means whereby student performance at higher levels of cognition can be encouraged.
In considering the opportunities students had to practice and perform at higher levels of cognition as a result of course experiences (discourse, tests, quizzes and assignments) it was found in this study that some instructors provided for, and expected, student performance at higher levels of cognition than others. It has been suggested that the nature of the subject matter may provide an explanation as to why instruction in some courses occurs at higher levels of cognition than instruction in other courses. For example, one might argue that the course content of an introductory agricultural mechanization or agricultural economics course lends itself more readily to the application, analysis and evaluation of information than what is taught in an introductory dairy science, food science or horticulture course.

There was some evidence in this study which may support the contention that higher levels of cognition are more likely to be witnessed in certain courses. The cognitive levels of discourse and tests were higher in the agricultural economics course in this study than the three remaining courses considered. Additionally, had the agricultural mechanization course from which data was collected been included in this study, the cognitive levels of course experiences in that course would have been higher than cognitive levels of course experiences in the four classes reported in this study.
Other findings in this study fail to support the contention that the cognitive level of instruction is linked with the nature of the subject matter however. The cognitive level of course experiences represented by the total weighted cognition scores for discourse, tests and assignments were higher in the horticulture and dairy science courses studied than in the agricultural economics course. Both the horticulture and dairy science course were seen to have no particular predisposition to including course experiences at higher levels of cognition. Conflicting findings such as these warrant further study of the issue of whether the cognitive level of instruction is, in part, dependent upon the subject matter of the course.

**Student Cognitive Performance**

Having considered aspects of the cognitive levels of course experiences found in the study, the impact of these experiences upon student cognitive performance should be appraised. Analysis of changes in student cognitive performances between the beginning and completion of each of the courses studied was based upon the DCAT pretest and posttest as well as a subject matter pretest and course final examination. Inasmuch as the subject matter pretest and final examination administered in each of the courses were non-equivalent, it is questionable whether critical comparisons should be made based upon these instruments. However, identical forms of the DCAT were completed by the
students at the beginning and completion of each course which does provide a common ground for assessing changes in student cognitive performance during the courses.

While changes in DCAT scores from pretest to posttest were minimal in most cases, two interesting findings were noted concerning improved performance on the DCAT posttest. These findings were evidenced in the agricultural economics and horticulture courses.

In the agricultural economics course, there was an apparent increase in students' cognitive performance on the critical thinking skills sections of the DCAT. Students averaged 55.6% correct responses to the critical thinking skills items on the pretest and 61.4% correct responses to the same items on the posttest. This was an increase from an average of 10 critical thinking items correct per student on the pretest to an average of 11 critical thinking items correct per student on the posttest (out of 18 items).

In considering factors which may have prompted this increase in agricultural economics students' critical thinking performance, two variables studied offered a possible explanation for increased student performance. These variables were cognitive levels of instructor discourse and cognitive levels of tests and in the agricultural economics course. Weighted cognition scores of these two variables indicated that discourse and tests in the agricultural economics class were at higher levels of
cognition than discourse and tests in the three remaining courses studied. Consequently, students in this course were more likely to observe and demonstrate cognitive thought at the application, analysis, synthesis and evaluation levels of cognition than students in other courses studied. This additional exposure to the processes of thinking at higher levels of cognition can be considered a possible influential factor which prompted improved student performance on the critical thinking skills section of the DCAT by agricultural economics students.

A second notable change in student performance on the DCAT was found in the horticulture course. Horticulture students average performance on the DCAT increased to a limited extent in all sections of the test between the beginning and completion of the course. No other group of students studied consistently posted higher scores on all sections of the DCAT posttest than on the pretest. One possible explanation for improvement in student cognitive performance which may have taken place in the horticulture course was the number, type, and cognitive level of assignments given in the course. The assignments given in the horticulture class were greater in number, broader in scope, of a greater value on students' final grade, and involved higher cognitive level tasks than those assignments given in the remaining three courses studied. These assignments allowed horticulture students to practice and
perform at the higher levels of cognition to a greater extent than other students studied. Because practice and performance at the higher levels of cognition involved operating at lower levels of cognition as a prerequisite, skills in functioning at the lower levels of cognition may have been enhanced as well. The would account for improved scores at all levels of the DCAT posttest in the horticulture course.

**Improving Instruction**

These findings lend credence to the assertion that course experiences should provide opportunities for demonstration, practice and performance of thought at the highest levels of cognition if students are expected to apply, analyze, synthesize or evaluate information. Unfortunately, it appears that few instructors give attention to designing tests, assignments or lesson plans (plans of discourse) that intentionally seek to prompt student thought at the application, analysis, synthesis and evaluation levels of cognition. Efforts have been made by the Ohio State University Department of Agricultural Education to assist College of Agriculture instructors in raising their cognitive level of instruction. Continued pursuit of enhanced instruction in the College of Agriculture appears to be in order.

In considering the findings of this study and pondering the observations made in the data collection process, the
researcher has noted two major points which may facilitate the realization of instruction at higher levels of cognition in the College of Agriculture. These points follow. It should be noted prior to presenting these points however, that it appears that until instruction at higher levels of cognition takes place in the College of Agriculture, it is unlikely that notable improvement in student performance at higher levels of cognition will be evidenced.

Instructors, for the most part, appear to be unaware of fact that various types of discourse, test questions or assignments can prompt student thought at various levels of cognition. In order to rectify this problem, instructors must first be made cognizant of the thought processes associated with each of the levels of cognition in order to vary their course experiences.

A second step which appears to be necessary in order to facilitate instruction at higher levels of cognition is the provision of guidance in showing professors how instruction at higher levels of cognition can be integrated into courses. Specific points meriting consideration include planning of lessons (discourse) which include more examples of application, analysis, synthesis and evaluation of facts, writing test items at all levels of cognition, and developing assignments which focus upon student performance at the higher levels of cognition.
Considering the need for improved instruction in the College of Agriculture, as well as further research into the cognitive aspects of teaching and learning, the following recommendations are offered.

**Recommendations**

The following recommendations focus upon two areas, recommendations for college instructors and agricultural educators and recommendations for further research in this field.

**Recommendations for College Instructors and Agricultural Educators**

**Recommendation 1.** Instructors should place more emphasis upon discourse at the higher levels of cognition than they are currently doing. While instruction at the knowledge and comprehension levels of cognition is essential, discourse at the application, analysis, synthesis and evaluation levels should be provided for students as well in order to demonstrate these levels of thought in the subject matter area.

The following two suggestions are offered as possible means whereby instruction at higher levels of cognition might be facilitated. First, instructors need an awareness of the cognitive levels at which they teach. Second, instructors should focus upon the overall objectives for the
course and evaluate whether teaching practices that they are using will facilitate the attainment of these objectives by students. Consideration of what is expected of students at the completion of course should provide an indication of the cognitive levels of instruction and evaluation that must occur in the course.

**Recommendation 2.** Instructors should give tests, quizzes and examinations which include items at all levels of cognition. Failure to include items at the higher levels of cognition results in failure to determine whether students can use or apply the body of subject matter knowledge that they possess.

**Recommendation 3.** Instructors should allocate a greater percentage of students' final grade to assignments. This practice would encourage students to focus more attention upon an aspect of the course that typically involves thought at the higher levels of cognition. It is suggested that assignments be designed to require tasks involving the application, analysis, synthesis or evaluation of information rather simple recall, translation, or interpretation of facts.

**Recommendation 4.** Agricultural educators should provide the means whereby all instructors in the College of Agriculture are able to consider the role that their teaching and evaluation practices play in the cognitive development of students. Workshops for instructors in the
College of Agriculture which provide a basic understanding of the various levels of cognition and suggestions for incorporating higher cognitive level thinking in discourse as well as tests, quizzes, examinations and assignments are a feasible means whereby this can be accomplished. Such workshops have been provided in recent years in the OSU College of Agriculture and they appear to have been successful in raising instructors' consciousness regarding the cognitive level of their teaching and evaluation. These workshops should continue to be offered and efforts be made to include more professors in the College of Agriculture in such workshops.

**Recommendations for Further Research**

The procedures followed and results obtained in this study have led to the proposal of the following recommendations for further research.

**Recommendation 1.** Similar studies done in the future should include a larger number of instructors. Additional instructors are required to provide the potential for added variability with regards to the cognitive levels of discourse, tests and quizzes, assignments, and instructor experience. This added variability may facilitate the identification of variables representative of instruction or the instructor that are associated with the cognitive level of student performance.
Recommendation 2. Studies considering the effectiveness of providing instructors with an understanding of the levels of cognition and how they might be utilized in discourse and student evaluation are needed. Further research could assess whether providing instructors with this type of information might actually make a difference in their cognitive levels of teaching and evaluation and subsequently impact upon the cognitive performance of students.

Recommendation 3. A number of procedural changes should be considered in conducting similar research studies in the future. These are as follows.

3A. Comparable subject matter pretests and posttests should be used. A similar percentage of items at each of the levels of cognition will equate pretests and posttests and will facilitate comparisons within and among courses. Two alternatives for ensuring a comparable subject matter pretest and posttest within courses are 1) using the same pretest, or an equivalent form, as the posttest also or, 2) using the course final examination as the posttest. If the second alternative is chosen, it may be necessary for the researcher to assist the instructor in modifying the final examination in order to insure an adequate percentage of items at each of the levels of cognition.

3B. Efforts should be made to develop pretests which can assess students' subject matter knowledge and cognitive
performance with a greater degree of reliability. Pilot testing of pretests should be considered if feasible. Additionally, the number of items included on the pretests should be increased in order to improve the reliability of these instruments.

3C. Other means of collecting information indicating students' academic ability should be considered. Additional indicators of student academic ability, such as high school grade point average, may be used.

3D. When possible, the administration of instruments completed during class periods should be done on days when student attendance is expected to be high, such as when assignments are due or quizzes are scheduled. Following the administration of each instrument, the researcher should make every reasonable effort to conduct follow-ups and obtain missing data.

3E. Solicit instructors to encourage students to return instruments completed outside of class. In this study, two instruments were completed outside of class. The 100% response received in the horticulture course was due largely to instructor encouragement for students to complete and return the instruments.
APPENDIX A

Description of Bloom's Taxonomy of Educational Objectives
DESCRIPTION OF BLOOM'S TAXONOMY

I. KNOWLEDGE LEVEL

A. Consists of memorizing and identifying facts. It is a student's "file" of information that can be recalled or brought to mind later. It provides the basis for greater understanding (Chamberlain and Kelly, 1981).

B. The knowledge level ranges from specific concrete facts or information to more complex and abstract theory. The knowledge level of the taxonomy is divided into the following sub-levels (Hunkins, 1972):

1. Knowledge of Specifics - the recall of specific, separate bits of information. This type of information provides the student with a data base.
   a. knowledge of terminology - definitions
   b. knowledge of specific facts - includes dates, events, persons, places, etc.

2. Knowledge of Ways and Means of Dealing With Specifics - knowledge of the ways of organizing, studying, judging and criticizing. Does not
require the student to be able to understand or use the concept; only requires an awareness of the concept.

a. Knowledge of conventions - awareness of the accepted way of dealing with types of information or situations. Example: "What is the correct form for a business letter?"

b. Knowledge of trends and sequences - questions students' knowledge of various phenomena in relation to the dimension of time. The emphasis is not on student understanding of the trend, but only that they recognize that it exists. Example: "What were the events that led up to World War II?"

c. Knowledge of classifications of categories - emphasis is placed upon students remembering certain groups of information. They are not required to do anything with the categories; they are only asked to recall from memory certain classifications. Example: "What are the four basic food groups, and which foods are contained in each?"

d. Knowledge of criteria - emphasis is on awareness of criteria developed.
Knowledge Level (continued)

Identification or listing of criteria is requested, not an understanding of the basis for the establishment of criteria. Example: "Name three criteria for judging the quality of a cut of meat."

e. Knowledge of methodology - this dimension is concerned with the students' awareness of methods or processes, not his/her ability to apply them in actual situations. Example: "If a teacher wishes to individualize instruction, the first step should be to:

(1) Select materials.
(2) Consider his/her own competencies
(3) Diagnose the abilities, needs and interests of the students in the class.
(4) Get permission from the principal.

f. Knowledge of universal and abstracts - deals with principles, generalizations, theories, and structures. Questions at this level are asking only for an awareness of various abstractions. Example: "What is the basic structure of the discipline of economics as presented in class?"
II. COMPREHENSION LEVEL

A. This level focuses on the meaning and intent of the material. It involves the ability to understand the literal meaning of the subject matter. The comprehension level has been divided into three sub-levels (Hunkins, 1972).

1. Translation - focuses on the students' ability to translate or paraphrase information. Knowledge is required, but the emphasis is on using this knowledge to understand material. Translation could involve:
   a. repeating what the author said, using the learner's own words.
   b. translation of one language to another.
   c. translation of information from technical terms to layman's terms.

2. Interpretation - emphasis is on grasping the basic ideas or general meaning of the material.
   a. The learner must be able to translate each major part of the material so that it becomes meaningful.
   b. The learner must then rearrange or reorder the material to determine significant and non-significant portions.
c. The learner must finally be able to relate the information (fact, generalization, definition, skill, etc.) to new situations.

3. Extrapolation - extends the ability to translate and interpret by student’s expanding the information to determine implications, consequences, effects, etc. based on the original communication.

III. APPLICATION LEVEL

A. Application questions are designed to give students practice in the transfer of training; applying what has been learned to other situations and learning tasks.

B. There are three main characteristics of questions in the application category (Sanders, 1966).

1. They deal with knowledge which has explanatory or problem-solving power - the kind of knowledge transferable to many situations.

2. They deal with whole ideas or skills, rather than with parts.

3. They include a minimum of directions or instructions; part of the challenge lies in
Application Level (continued)

the student being able to determine the appropriate problem solving process to use.

C. Evidence shows that once the ability to apply knowledge is developed, it is likely to be one of the more permanent acquisitions in learning (Bloom et al., 1981).

IV. ANALYSIS LEVEL

A. Analysis may be regarded as an advanced step in understanding an idea, product or document. It requires the student to "see" the underlying ideas, devices, and workings of a document or communication (Bloom et al., 1981).

B. While analysis is slower and more difficult than the comprehension process, its use is critical when a deeper understanding is required before decisions are reached or problems are addressed (Bloom et al., 1981).

C. It is likely that once analytical abilities are developed in a number of fields of knowledge, they can be applied to new problems in a creative way (Bloom et al., 1981).

D. Analyzing includes: (1) separating relevant material from trivia; (2) distinguishing facts from
hypotheses; and (3) differentiating between objective data and value judgements. (Chamberlain and Kelly, 1981).

E. Bloom et al. (1956) divided the analysis level into three sub-levels:

1. Analysis of Elements - the student is expected to break down the material into its constituent parts then identify and classify those parts.

2. Analysis of Relationships - the student differentiates between various relationships among elements and determines their connection and interaction.

3. Analysis of Organizational Principles - the student is able to determine the author's purpose, point of view, attitude, or general conception of the field in order to better comprehend the meaning of the material.

V. SYNTHESIS LEVEL

A. Synthesis questions encourage students to think creatively and make original conclusions. It is the ability to put parts and elements together in a form new to the students (Chamberlain and Kelly, 1981).
Synthesis Level (continued)

B. This is the category in the cognitive domain which most clearly provides for creative behavior on the part of the learner; this work is still expected to be within the limits set by a particular problem, theory or method.

C. Bloom et al. (1956) have divided the synthesis level into three sub-levels; these levels are distinguished on the basis of the product developed through the synthesis process.

1. Production of a Unique Communication - the student originates a work that produces ideas, feelings, and experiences that are uniquely his/hers; the interpretation should represent the students' individual thinking and personality.

2. Production of a Plan - requires the student to produce a plan or solution to address a particular situation.

3. Derivation of a Set of Abstract Relations - requires students to create or derive some type of statement to explain or classify data or a situation. The student can formulate a concept or generalization from the analysis of data.
D. Sanders (1966) has identified various strengths and weaknesses of synthesis questions:

1. Strengths of Synthesis Questions
   a. Allows students great freedom in seeking solutions.
   b. The question has many possible approaches to achieve the answer; the student must understand that the teacher does not have a definite answer in mind.
   c. The solution requires a product.

2. Weaknesses of Synthesis Questions
   a. Asks questions that call for mental creativity, but often may have no correlation with course objectives.
   b. There is the possibility of developing questions that are totally beyond the competence of the student.
   c. It is difficult to evaluate the answers fairly.
   d. It is often difficult to provide conditions favorable for creative work.
VI. EVALUATION LEVEL

A. Evaluation questions are those requiring the student to make a judgement about something, using some criteria or standard for making the judgement (Clegg, 1967).

B. Bloom make the point that evaluation is not an activity done after all other levels of intellectual skills have been used. To some degree, evaluation can be considered a 'floating' category in that it can be evidenced at each level of intellectual activity (Hunkins, 1972).

C. Bloom et al. (1956) have divided the evaluation level into two sub-levels.

1. Evaluation in Terms of Internal Evidence - requires the student to analyze data or conclusions from criteria such as logical accuracy, consistency, and other internal criteria.

2. Evaluation of Terms of External Criteria - focus is on having students apply known criteria to judge various situations or conditions that are encountered or that develop.

APPENDIX B

Florida Taxonomy of Cognitive Behavior
PLEASE NOTE:

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These consist of pages: 194-195
APPENDIX C

Observation Form
<table>
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<tr>
<th>Interval (min.)</th>
<th>Time</th>
<th>Counter</th>
<th>Description of Class</th>
<th>Teaching Aids Used</th>
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APPENDIX D

Motivated Strategies for Learning Questionnaire
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These consist of pages: 199-202
APPENDIX E

Student Demographic Information Questionnaire
DEMOGRAPHIC INFORMATION

1. Student Identification Number ____________________

2. Gender (circle one) Male Female

3. Age in years __________

4. What year did you graduate from high school? __________

5. ACT Composite Score _______ and/or SAT Score __________

6. Class level (circle one)
   Freshman Sophmore Junior Senior

7. Ethnic Background (optional, circle one)
   Afro-American Asian- Caucasian Hispanic Other
   or Black American

8. Marital Status (circle one)
   Single Married Divorced/Widowed

9. How many children do you have that live at home with you? ______

10. How many hours per week do you work for pay? _________

11. How many other college courses have you had in this subject area? __________

12. What final grade do you expect to get in this class?

13. Reasons for taking this class
   (circle yes or no for each item)
   a. Fulfills distribution requirement Yes No
   b. Content seems interesting Yes No
   c. Will be useful to me in other courses Yes No
   d. Is an easy elective Yes No
   e. Will help to improve my academic skills Yes No
   f. Is required for major (or program) Yes No
   g. Was recommended by a friend Yes No
   h. Was recommended by a counselor Yes No
13. Reasons for taking this class (continued) (circle yes or no for each answer)
   i. Will improve career prospects Yes No
   j. Will transfer to another college Yes No
   k. Fit into my schedule Yes No

14. Previous experiences related to this course
   a. This was my first experience with the materials and concepts presented in this course. Yes No
   b. I have studied similar material and concepts in other college courses. Yes No
   c. This course builds upon materials and concepts from other college courses Yes No
   d. My high school courses were related to the materials and concepts presented in this course Yes No
   e. I completed two or more years of vocational agriculture courses in high school which included course materials and concepts similar to this course Yes No
   f. In high school, I was actively involved in FFA activities that related to the materials and concepts presented in this course Yes No
   g. I was involved in projects for two or more years in my county 4-H program that related to the materials and concepts presented in this course Yes No
   h. I have two or more years of work experience in agriculture directly relate to this course Yes No

I agree to allow the researchers in this study access to my completed final examination for this course with the provision that any information gathered remains strictly confidential and anonymous.

__________________________
Signature

THANKS FOR YOUR COOPERATION!
APPENDIX F

Instructor Previous Experience Questionnaire
Instructor Previous Experience

A. Please indicate the total number of years of university teaching experience that you have

_______ years

B. Please indicate the total number of quarters/semesters that you have been 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 of teaching in the university setting that you have had related to the course content

_______ years

D. I consider my primary area of expertise to be:

________________________

E. I consider my secondary area of expertise to be:

________________________
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 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.

3. 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 material and concepts presented in this course.

4. 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 with issues related to materials and concepts presented in this course.
   B. I have some experiences in the agricultural community with issues related to the materials and concepts presented in this course.
   C. I have had limited involvement in the agricultural community with issues related to the materials and concepts presented in this course.
LIST OF REFERENCES


Bell, D. R. (Ed.). (1988, April). The Ohio State University Course Bulletin Course Offerings, 92 (9), Columbus: Ohio State University Printing Facility.


Chuatong, P. (1985) An analysis of levels of cognitive processes implied in assignments and tests used by agriculture professors at the Ohio State University. Unpublished manuscript, The Ohio State University, Department of Agricultural Education, Columbus.


Golden, J. (1981). [Videocassette]. Columbus, OH: Ohio State University, Department of Agricultural Education.


Plimpton, R. (1981). [Videocassette]. *Sheep lecture*. Columbus: The Ohio State University, Department of Agricultural Education.


