THE COGNITIVE ABILITY AND LEARNING STYLE OF STUDENTS
ENROLLED IN THE COLLEGE OF AGRICULTURE AT
THE OHIO STATE UNIVERSITY

DISSERTATION

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

By

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*****

The Ohio State University
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DEDICATION

Dedicated to my parents, Luis O. and Bernice T. Torres
ACKNOWLEDGMENTS

Several individuals have contributed to the successful completion of my doctoral program in Agricultural Education at The Ohio State University. To them, I offer extensive thanks and appreciation for significant contributions which embellished my experiences and opportunities as a graduate student.

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CHAPTER I
INTRODUCTION

The discipline called education is constantly under public scrutiny. One of the most proclaimed documents to make a critical observation of American education was the report prepared by the 1983 National Commission on Excellence in Education, entitled the *A Nation at Risk: The Imperative for Educational Reform*. Several claims were leveled against the Nation's schools and colleges regarding the decline in educational performance resulting from inadequacies in the way the educational process was conducted.

The National Commission on Excellence in Education (1983) specifically focused criticism in the area of critical thinking, higher level thinking, and problem solving ability of students. The Commission heard evidence on the cognitive ability of students, citing that 40 percent of 17 year olds could not draw inferences from written materials (National Commission on Excellence in Education, 1983). Many of the claims cited by the 1983 National Commission on Excellence in Education are still present today in elementary, secondary, and higher education (USDE, 1991).
Cognitive Ability

The concerns expressed by the National Commission on Excellence in Education (1983) about students' critical thinking, higher level thinking, and problem solving ability were similar at the college level. Boyer (1987) indicated that effective writing and critical thinking were the most essential skills for further education and work.

The criticism of students' lack of ability to think is not new. John Dewey, known as the father of education, was an advocate of developing thinking skills in students. Dewey (1944) indicated that "there is not adequate...recognition that all which the school...need do for pupils, so far as their minds are concerned, is to develop their ability to think" (p. 96).

Bloom, Englehart, Furst, Hill, and Krathwohl (1956) labeled critical thinking, higher order thinking, and problem solving as "intellectual abilities and skills" (p. 38) and operationally defined evidence of the intellectual abilities and skills as an individual being able to "find appropriate information and techniques in his [sic] previous experience to bring to bear on new problems and situations" (p. 38). Miller (1989) indicated that intellectual abilities and skills as defined by Bloom et al. (1956) provided a point of reference for considering the types of cognitive abilities.

To assist in categorizing the levels of cognition, Bloom and his associates developed the Taxonomy of Educational
Objectives Handbook I: Cognitive Domain (Bloom et al., 1956) commonly referred to as Bloom's taxonomy. The purpose of the taxonomy was to facilitate communication among educators and help gain a perspective on the emphasis given to certain cognitive behaviors (Bloom et al., 1956).

Bloom's taxonomy consists of six major levels of cognition. The levels of cognition are assumed to possess a cumulative hierarchical structure increasing in complexity from the simplest level of cognition, Knowledge, to Comprehension, Application, Analysis, Synthesis, and finally to the most complex level of cognition, Evaluation. Bloom's taxonomy also distinguishes between "knowledge of fact" and "demonstration of intellectual skills and abilities" (Bloom et al., 1956, p. 39). A detailed description of Bloom's taxonomy is provided in Appendix A.

Intellectual Skills and Abilities are composed of the upper five cognitive level of Bloom's taxonomy encompassing Comprehension, Application, Analysis, Synthesis, and Evaluation. Bloom et al. (1956) based their arrangement of cognitive behaviors from simple to complex "on the idea that a particular simple behavior may become integrated with other equally simple behaviors to form a more complex behavior" (p. 18) (Table 1).

Bloom et al. (1956) recognized the importance of developing cognitive abilities in students when they stated that:
"Justification for the development of intellectual abilities and skills can readily be derived from a consideration of the nature of the society and culture in which we live, the knowledge that is available to us, and the kind of citizen the schools seek to develop." (p. 39)

Bloom et al. (1956) further stated that:

"[Educators] have the task of preparing individuals for problems that cannot be foreseen in advance, and about all that can be done under such condition is to help the student acquire generalized intellectual abilities and skills which will serve him [sic] well in many new situations." (p. 40)

Table 1

**Taxonomy of Educational Objectives - Cognitive Domain**

<table>
<thead>
<tr>
<th>Category</th>
<th>Behavior</th>
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<tbody>
<tr>
<td>Knowledge</td>
<td>remember</td>
</tr>
<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>breakdown concept into components</td>
</tr>
<tr>
<td>Synthesis</td>
<td>use parts or elements to form a whole</td>
</tr>
<tr>
<td>Evaluation</td>
<td>judge value of materials or methods</td>
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Learning Style

There are a number of factors that have emerged on the human developmental stages and life phases that influence the educational process. One factor researchers (Dunn & Dunn, 1979; Claxton & Murrell, 1987; Garger & Guild; 1984; Saracho, 1989; Witkin, 1973) have claimed to influence educational performance in students is learning style.

Claxton and Murrell (1987) suggested that learning style could be an extremely important element in the move to improve curricula and the teaching process in higher education. Learning style of students in all ages groups provides another view from which the similarities and individual differences may be understood. Gregorc (1979) defined learning style as consisting "...of distinctive behaviors which serve as indicators of how a person learns from and adapts to his environment. It also give clues as to how a person's mind operates" (p. 234).

Witkin (1976) described learning style as "cognitive characteristic modes of functioning in what we reveal through our perceptual and intellectual activities in a highly consistent and pervasive way" (p. 39). Learning style research has been applied at an ever increasing rate to the problem of education (Doebler & Eicke, 1979). Supporting Doebler and Eicke's (1979) claim was the recently released document America 2000 (USDE, 1991), known as President Bush's

Messick (1970) identified nine learning styles in his discussion of various types of learning styles of which field dependence/independence was identified. A renowned researcher in the area of field-dependence/independence learning styles was Herman A. Witkin. According to Guild and Garger (1985), the work by Witkin "is the most extensive and in-depth research on cognitive [learning] style conducted in the last 50 years" (p. xii). Witkin (1976) referred to field-dependence as being relatively influenced by the surrounding field; it was difficult for a person to separate a pattern from the surrounding environment. Conversely, Witkin (1976) referred to field independence as being relatively uninfluenced by the surrounding field and having a well-developed perception of discrete parts.

Witkin, Moore, Goodenough, and Cox (1977a) indicated that the field dependence/independence dimension was bipolar, in the sense of not having a clear high or low end. Witkin et al. (1977a) suggested that individuals at each end of the dimension were high in some characteristics and low in others, adding that it was not inherently better or worse to be located at one pole or the other.

Results from research on learning styles indicated that the field-dependence/independence dimension tended to influence students' preference for a particular learning
method and the learning process (Witkin, 1973). Learning style is also a potential variable influencing students' academic choices and vocational preferences, the students' academic development, how students learn, and how students and teachers interact in the classroom (Eleuterius, 1987; Johnson, 1987; Linton, 1952; Witkin, 1976; Zabarah, 1987).

**Statement of the Problem**

Several researchers (Miller, 1989; Newcomb & Trefz, 1987; Pickford, 1988; Whittington, 1991) have investigated the cognitive levels of learning in students and cognitive levels of instruction by faculty in the College of Agriculture at The Ohio State University. Newcomb and Trefz (1987) assessed the cognitive levels of teaching by professors. Pickford (1988) investigated relationships between students' cognitive achievement and selected variables. Miller (1989) assessed the factors associated with the ability of college students to perform at the higher levels of cognition. Most recently, Whittington (1991), investigated the aspired cognitive levels or instruction, assessed cognitive level of instruction and attitude toward teaching at the higher levels of cognition by professors.

Although progress in research has been achieved in the area of teaching and learning in the College of Agriculture at The Ohio State University, research is limited. A problem still exists, in that professors in the College of Agriculture
at The Ohio State University lack evidence on the cognitive abilities and learning styles of students enrolled in the College of Agriculture.

**Purpose of the Study**

The purpose of the study was to describe the cognitive abilities and the learning styles of students enrolled in the College of Agriculture at The Ohio State University. Furthermore, the study sought to relate cognitive abilities to selected student characteristics, including learning style.

**Research Objectives**

To achieve the purpose of the study, the following objectives were developed. The objectives were to:

1. Describe senior students in the College of Agriculture at The Ohio State University on the following personalogical variables: age, gender, ACT composite score, cumulative GPA, choice of academic major, and ethnic background.
2. Determine the cognitive abilities (Basic, Application, and Critical Thinking) of senior students enrolled in the College of Agriculture at The Ohio State University as measured by the Developing Cognitive Abilities Test (DCAT), Level L.
3. Determine the learning style of senior students enrolled in the College of Agriculture at The Ohio State University.
University as measured by the Group Embedded Figure Test (GEFT).

4. Describe the relationships between cognitive abilities (Basic, Application, and Critical Thinking) utilizing the DCAT and selected variables (age, gender, cumulative GPA, ACT composite score, academic major, ethnic background) of senior students enrolled in the College of Agriculture at The Ohio State University.

5. Describe the relationship between learning style utilizing the GEFT and selected variables (age, gender, cumulative GPA, ACT composite score, academic major, ethnic background) of senior students enrolled in the College of Agriculture at The Ohio State University.

6. Describe the relationships between cognitive abilities (Basic, Application, and Critical Thinking) utilizing the DCAT and learning style utilizing the GEFT of senior students enrolled in the College of Agriculture at The Ohio State University.

Limitations of the Study

The nature of this study was descriptive and relational. Borg and Gall (1979) cautioned that a relational study cannot establish cause-and-effect relationships among variables. Therefore, the researcher sought only to describe and explain relationships among variables.
The study was limited to students enrolled in the College of Agriculture and excluded the School of Natural Resources. Only College of Agriculture students holding a class rank of Senior during the Autumn Quarter, 1993, were included in the study.

The instrument entitled Developing Cognitive Abilities Test, Level L (the highest test level available), was utilized to collect data on cognitive abilities (Basic, Application, and Critical Thinking) of students. The test was developed for students enrolled in grade twelve. However, the subjects in the current study were of college level, thus "ceiling effect" was a consideration.

Beggs (Personal communication, September, 1992) indicated that there was limited potential for the DCAT, Level L, to have a "ceiling effect" when utilized with college students. Beggs (Personal communication, September, 1992) further suggested that of the three content areas (verbal abilities, quantitative abilities, and spatial abilities), the verbal abilities area had the greatest chance of "ceiling effect."

In a study conducted by Miller (1989), the DCAT, Level L, was used with college students. Miller (1989) used two (verbal and quantitative abilities) of three (verbal, quantitative, and spatial abilities) content areas of the DCAT. Miller (1989) reported a possible "ceiling effect" in the verbal and quantitative abilities content areas.
Significance of the Problem

Several national documents (A Nation At Risk: The Imperative for Educational Reform, 1983; Involvement in Learning: Realizing the Potential of American Higher Education, 1984; To Reclaim a Legacy, Bennett, 1984; Integrity in the College Curriculum, 1985; To Secure the Blessings of Liberty, 1986; College: The Undergraduate Experience in American, Boyer, 1987) have stressed the need to develop student's thinking and learning skills of students in higher education. Feldman and Newcomb (1969) reviewed and synthesized results of over 1,500 studies pertaining to the impact of college on students. The major focus of the literature was on the ways in which college influenced many student factors (e.g., values, attitudes, personality orientations, political and racial views, educational and occupational aspirations, income, life goals) (Pascarella, 1985). However, only a small percentage of research was concerned with the effects of college on learning and other cognitive developments (Pascarella, 1985).

Such is the case in the College of Agriculture at The Ohio State University. Limited research was available on the unique needs for cognitive development of students enrolled in the College of Agriculture. Professors in the College of Agriculture encounter a student body composed of individuals of diverse backgrounds, including personal characteristics,
cognitive abilities, and learning styles (Escolme, 1988; Pickford, 1988; Miller, 1989).

Under the leadership of Newcomb, research in the College of Agriculture at The Ohio State University has assessed the cognitive levels of teaching and learning (Newcomb & Trefz, 1987; Miller, 1989; Whittington, 1991). Research examined the relationships between student achievement and selected student and teacher variables (Pickford, 1988); appraised level of instruction of professors' discourse (Miller, 1989); and aspired and assessed cognitive level of instruction and attitude toward teaching at the higher cognitive levels (Whittington, 1991).

Also needed, is research on the cognitive abilities of students enrolled in the College of Agriculture. Thus far, Miller (1989) and Pickford (1988) have been the only investigators of the cognitive performance of students enrolled in the College of Agriculture. Further investigation was warranted to add insight into the cognitive abilities of students.

Research on cognitive abilities of students could clearly contribute to the teaching and learning process in the College of Agriculture at The Ohio State University. Research on students' cognitive abilities could explore the links between cognitive abilities and age, gender, cumulative GPA, ACT composite score, ethnic background, and choice of academic major of students enrolled in the College of Agriculture at
The Ohio State University. The results could have implications for all academic disciplines and further research efforts on teaching and learning in higher education.

In addition, the investigation of students' learning style in the College of Agriculture was warranted. In the book, *New Directions for Teaching and Learning*, Anderson and Adams (1992) indicated that more attention than ever was being focused on how to meet the challenge of increasing diversity in the classroom. Anderson and Adams (1992) suggested that:

"One of the most significant challenges that university instructors face is to be tolerant and perceptive enough to recognize learning differences among their students. Many instructors do not realize that students vary in the way they process and understand information. The notion that students' cognitive skills are identical at the collegiate level [suggests] arrogance and elitism by sanctioning one groups' style of learning while discrediting the style of others." (p. 19)

Currently, research on learning style in the College of Agriculture at The Ohio State University was limited to the efforts of Escolme (1988), Cano and Garton (1992a, 1992b), Cano, Garton, and Raven (1991, 1992), and Raven, Cano, Garton, and Shellenhammer (1992). The efforts of the related research was limited to a small number of graduate students and
students majoring in Agricultural Education. An expansion of research on students' learning style was required.

If College of Agriculture professors at The Ohio State University are to teach more effectively, evidence on students' learning style must be established. Research on students' learning style also provides insight on the link of learning style to cognitive abilities, age, gender, cumulative GPA, ACT composite score, ethnic background, and choice of academic major of students enrolled in the College of Agriculture at The Ohio State University.
CHAPTER II

REVIEW OF RELATED LITERATURE

The purpose of the study was to describe the cognitive abilities and the learning style of students enrolled in the College of Agriculture at The Ohio State University. Furthermore, the study sought to relate cognitive abilities to selected student characteristics, including learning style.

There was a modest body of literature on the impact of college on students' cognitive development and learning. The literature review in Chapter II focused on two variable strands related to students' academic achievement. The first strand of literature centered on cognitive ability. Literature was sought regarding Piaget's theory on cognitive development, Bloom's taxonomy, research related to cognitive development, and gender differences in cognitive ability.

The second strand of literature concentrated on learning style. A background to learning style was provided, followed by literature on learning style measurement, determinants of learning style, characteristics and behaviors of field dependence/independence learning style, factors related to learning style, and gender differences in learning style.
Cognitive Ability

Piaget's Theory on Cognitive Development

The study of cognition has become an interdisciplinary field encompassing linguistics, anthropology, artificial intelligence, philosophy, psychology, and education (Gardner 1985; Stevens & Gentner, 1983). Egan (1983) indicated psychological theories about cognitive development were generally accepted as truisms that could yield implications for educational practice. Cognitive development refers to "the way in which a child's understanding of the world changes as a function of age and experiences" (Royer & Feldman, 1984, p. 64) and whose cognitive development theory has been the most profound in the field of education. Among those who have studied cognitive development, Piaget is considered to be the most influential (Meadows, 1983). Piaget's work dominated the study of cognitive development for half a century (Rotman, 1977).

Jean Piaget, a Swiss psychologist, began his work in psychology in 1919, when he became involved in the work of Alfred Binet, who was refining his standardized intelligence tests. Piaget developed little interest in Binet's concern with achieving accurate and reliable measures of intelligence; Piaget was more interested in the wrong answers that children often gave on tests (Egan, 1983).

Hunt (1969) pieced Piaget's work into three main periods. The first period, from the early 1920s to the mid-1930s,
involved studies of children's language and thought, judgement and reasoning, conception of the world and of physical causality, and moral judgements. During the first period, Piaget's method of research was almost entirely interrogation, rather than hypothesis testing, rigorous controls or experimental variables, and treatment of data with sophisticated procedures (Meadow, 1983). Piaget's form of research was much criticized. Hunt (1969) indicated that Piaget accepted some of the criticisms and increasingly began to invent experiments on the intellectual development of children.

The second period, from the mid-1930s to the mid-1940s, involved Piaget's observations of his own children from their first movements to their acquisition of language (Hunt, 1969). Piaget invested time in discovering how the learning process took place. During the second period, Piaget developed most of his theoretical formulations about the child's construction of reality as an assimilative and accommodative interaction with the environment.

The third period, beginning in the mid-1940s and continuing into the 1950s, involved clarifying the developing structures of thought from the earliest years to adolescence and beyond. Hunt (1969) indicated that many topics were studied by Piaget and his co-workers to expand on Piaget's theory of cognitive development in the years that followed.
Piaget's cognitive development theory proceeds in an orderly and systematic fashion through a series of four separate stages (Table 2) (Royer & Feldman, 1984).

Table 2

Summary of Piaget's Stages

<table>
<thead>
<tr>
<th>Approx. Age Range</th>
<th>Stage</th>
<th>Major Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth-2</td>
<td>Sensorimotor</td>
<td>Development of object permanence; little or no symbolic representation; development of motor skills</td>
</tr>
<tr>
<td>2-7</td>
<td>Preoperational</td>
<td>Development of language and symbolic thinking; egocentric thinking</td>
</tr>
<tr>
<td>7-12</td>
<td>Concrete operations</td>
<td>Development of conservation; mastery of concept of reversibility</td>
</tr>
<tr>
<td>12+ adulthood</td>
<td>Formal operations</td>
<td>Logical thinking; abstract thinking</td>
</tr>
</tbody>
</table>

Royer and Feldman (1984) elaborated on the four stages of Piaget's cognitive developmental theory. Stage one, sensorimotor, suggested that from birth until the age of 18-24
months, the child's behavior was limited to instinctual reflexes; and throughout the stage the infant had little or no competence in representing the world through images, language, or other sorts of symbols.

Stage two, preoperational, proposed that from the age of 2 to 7 the child developed internal representational systems that allowed him/her to use language to describe people, feelings, and occurrences, as well as demonstrate symbolic thinking. Moreover, the child displayed egocentric thought, in which the world was viewed entirely from the individual's own perspective (Royer & Feldman, 1984).

The concrete operations stage (age 7-12), stage three, the child developed reversibility, the major sort of understanding. Reversibility referred to the idea that some changes could be undone by reversing an earlier action. Although children had begun to think logically, there was still one major limitation to the quality of their thought: they were bound to concrete, physical reality; they could not understand hypothetical situations (Royer & Feldman, 1984).

The final stage, formal operations, suggested that from age 12 to adulthood, cognitive behavior was characterized by the ability of the individual to think in a formal, logical manner. Royer and Feldman (1984) suggested that when an individual in the formal operations stage was presented with a problem, the individual used logical techniques to try to determine the solution.
Piaget proposed that the way in which an individual advanced in cognitive development was through two complementary processes; assimilation and accommodation. Assimilation referred to the process by which an individual understood an experience in terms of his or her present stage of cognitive development (Royer & Feldman, 1984). Conversely, accommodation referred to changes that occurred in existing ways of thinking as a response to encountering new events or stimuli (Royer & Feldman, 1984).

Cognitive development, as suggested by Piaget, is the result of the assimilative and accommodative interactions with the environment. During the assimilative and accommodative interactions with the environment, the individual attempts to deal with the novel stimuli by assimilating them into his or her existing cognitive framework, or by accommodating them into new defined modes of thought (Royer & Feldman, 1984). Essentially, "Piaget's cognitive development theory suggested that the nature of children's thinking changes in four distinct ways as the child matures" (Royer & Feldman, 1984, p. 37).

Piaget's theory was primarily meant to explain behavior in terms of people in general and was not designed to explain individual differences (Royer & Feldman, 1984). However, Lerner (1976) suggested there were two important ways in which stage theories did approach the problem of how individuals differed. First, stage theories recognized differences in the
rate at which people progressed through the stages. Second, not all people were necessarily assumed to reach the highest stages of development (Lerner, 1976).

Studies (Collea, 1981; Day, 1981; Taylor & Dunbar, 1983) have suggested that students may still operate mostly at the concrete operational stage of Piaget's cognitive development theory. Piaget indicated that few individuals actually reached formal operations, and that teachers should not assume all teenagers, nor all adults, function at the formal level (Sprinthall, 1987). However, Piaget stated that proper education could accelerate the cognitive transition from a concrete to a formal stage which was a more desirable level of thinking (Taylor & Dunbar, 1983).

Piaget (1970) expressed his general view about the purpose of education when he wrote "...the aim of intellectual training is to form the intelligence rather than stock the memory, and to produce intellectual explorers rather than mere erudition" (p. 51). Piaget (1973) later added "the ideal of education is not to teach the maximum, to maximize the results, but above all to learn to learn, to learn to develop, and to learn to continue to develop after leaving school" (p. 30).

Bloom's Taxonomy

While Piaget provided educators with a theory on cognitive development, Bloom et al. (1956) supplied educators with one of the first systematic classifications of the
cognitive operations students use in attaining a variety of educational goals (Kunen, Cohen, & Solman, 1981). The systematic classification of cognitive operations was considered to be consistent with the authors' understanding of psychological phenomena (Bloom et al., 1956) and was commonly referred to as Bloom's taxonomy. During the 1950s and 1960s, no less than eleven cognitive classifications systems were developed (Ryan, 1973).

Bloom's taxonomy was created to facilitate communication among educators and help gain a perspective on the emphasis given to certain cognitive behaviors (Bloom et al., 1956). Furthermore, Bloom's taxonomy was designed to be a classification of intended student cognitive behavior which represented the outcomes of the educational process (Bloom et al., 1956). Furthermore, Bloom et al. (1956) suggested the classification of student cognitive behavior could be observed in a range of subject-matter content, at different levels of education (e.g., elementary, high school, college). Soon after its publication, Bloom's taxonomy began to influence curricular development and the construction of tests in both education and in professional organizations such as the American Society of Clinical Pathologists (Kunen, Cohen, & Solman, 1981). In addition, Bloom's taxonomy had been used in hundreds of research projects since its inception (Furst, 1981) and has dominated instructional design and evaluation for more than a quarter of a century (Stahl & Murphy, 1981).
Today, Bloom's taxonomy is a widely accepted model of the range of cognitive abilities used in education.

Levels of Cognition

In the *Taxonomy of Educational Objectives, Handbook I: Cognitive Domain*, Bloom et al. (1956) described the taxonomy as consisting of six major levels of cognition ordered from least to most complex. The Knowledge level was considered to be the lowest taxonomic category, since information was processed with a minimum of understanding. In contrast, the highest level taxonomic category, Evaluation, contributed to Bloom's taxonomy a cognitive component involving critical judgement and represented the cumulative contributions of the five preceding levels of cognition. The remaining four levels of cognition, Comprehension, Application, Analysis, and Synthesis, were arranged in order of cognitive complexity between the Knowledge and Evaluation levels of cognition.

Bloom's taxonomy further distinguished between "knowledge of fact" and "demonstration of Intellectual Skills and Abilities" (Bloom et al., 1956, p. 39). Intellectual Skills and Abilities as described by Bloom et al. (1956) were composed of the upper five cognitive levels of Bloom's taxonomy, including Comprehension, Application, Analysis, Synthesis, and Evaluation. In total, the six cognitive levels of Bloom's taxonomy were considered to be cumulative and hierarchical. Bloom et al. (1956) suggested that advancement to any higher cognitive level required the use of all
preceding levels of cognition. A detailed description of Bloom's taxonomy is provided in Appendix A.

Issues Concerning Bloom's Taxonomy

Despite its extensive application, Bloom's taxonomy has caused researchers and scholars to investigate and question issues pertaining to Bloom's taxonomy. The issues included philosophical issues and the validity and reliability of Bloom's taxonomy.

Philosophical Issues

Furst (1981) raised several major philosophical issues regarding Bloom's taxonomy. The first major issue centered on neutrality. A principle upon which Bloom's taxonomy was developed was neutrality. Meaning that Bloom's taxonomy had no ownership in one particular content area. Bloom et al. (1956) indicated that the taxonomy "should be a purely descriptive scheme in which every educational goal can be represented in a relatively neutral fashion" (p. 14).

Furst (1981) indicated that the neutrality of Bloom's taxonomy did not mean impartiality with respect to the concept of educational objectives. Bloom et al. (1956) were aware of Furst's (1981) claim when they ruled out neutrality from goals that were not specified as intended student behaviors. Furst (1981) argued that by this very admission, the taxonomy could not be neutral. Ormell (1974) indicated that it was not possible for any classification of educational objectives to
be free of questions of values and thus be a purely technical matter.

The second major issue pertaining to Bloom's taxonomy raised by Furst (1981) and others (Hirst, 1974; Ormell, 1974; Pring, 1971; Sockett, 1971; Wilhoite, 1965) focused on the epistemology upon which Bloom's taxonomy was based. Questions were raised regarding the epistemology pertained to the use of behavior-specific goals, distinction between behavioral (process) and substantive (content) elements in statements of educational objectives, and the distinction between cognitive and affective domains.

Behavior-specified goals as a means of identifying whether implicit processes took place, was the first question raised by Furst (1981). Furst (1981) indicated that Bloom's taxonomy took on the risk of confusing the overt objective with its indicator (evidence of change). A second concern regarding behavior-specified goals was that behavior-specified goals neglected important covert goals of education that were not readily observable (Furst, 1981) such as "understanding" or "desirable citizen" (Bloom et al., 1956). Furst (1981), however, recognized that the use of behavior-specified goals prevented the identification of goals that could not be easily recognized, such as "understanding" or "desirable citizen."

On the issue of epistemology, Furst (1981) also raised the question pertaining to the failure of Bloom's taxonomy to distinguish between behavioral objectives and content
objectives. Furst (1981) indicated that the authors of Bloom's taxonomy "...chose to classify objectives on the bases of intended behaviors, more or less disregarding the particular content" (p. 443). Bloom et al. (1956), aware that the taxonomy failed to distinguish between behavioral objectives and content objectives, suggested that it was "assumed that essentially the same classes of behavior may be observed in the usual range of subject-matter content" (p. 12).

The question regarding the distinction between cognitive and affective domains was also embedded in the issue of epistemology. Furst (1981) noted that the distinction created educational and philosophical problems by separating the world of knowledge from the world of values. The distinction between cognitive and affective domains was considered to be artificial by the authors of Bloom's taxonomy who realized that knowledge and values could not be separated (Miller, 1989).

The third major issue concerning Bloom's taxonomy pertained to comprehensiveness. Furst (1981) questioned if Bloom's taxonomy allowed for all the cognitive objectives to be classified. Certain researchers (Gall, 1970; Mills et al., 1980; Riegle, 1976) who tried to use Bloom's taxonomy for classifying oral questions in the classroom found it somewhat incomplete (Furst, 1981). Furst (1981) further added that the artificial separation of the cognitive domain from the
affective and psychomotor domains lead to the omission of desired outcomes of education. Educational outcomes omitted included "receptivity" and "sensitivity," skills in observing and gathering data, and activities labeled as "perceptual" or "motor" (Furst, 1981). Furst (1981) also identified group-procedure skills, moral concepts, basic democratic values and "rationality" as educational outcomes omitted from the taxonomy. Citing De Landsheere (1977), Furst (1981) wrote "while no one would consider [Bloom's taxonomy] to be perfect, most users generally have been satisfied with it" (p. 445).

The fourth major issue raised by Furst (1981) pertained to the cumulative hierarchical structure of Bloom's taxonomy. There was some question as to whether the taxonomic levels did exist in a hierarchy (Cano, 1987). Phillips and Kelly (1975) saw the cumulative hierarchical structure as too simplistic when applied to development theories in education.

Scholars (Moore & Kennedy, 1971; Orlandi, 1971; Pring, 1971; Purves, 1971) have suggested that activities aimed at lower levels of cognition in the taxonomy could activate mental operations placed in the higher taxonomic levels. Furst (1981) further questioned separation of the Knowledge level of cognition from the Intellectual Skills and Abilities, arguing that "to know in any important sense presupposes certain intellectual skills" (p. 447).

Other criticisms of a philosophical nature of Bloom's taxonomy included those by Travers (1980), DeCorte, (1973,
cited in De Landsheere, 1977), and Gagne (1964). Travers (1980) saw Bloom's taxonomy as falling short of a true taxonomy, suggesting that the taxonomy lacked the theoretical underpinning of true taxonomies. DeCorte (1973, cited in De Landsheere, 1977) concluded that the subcategories of Bloom's taxonomy were not always based on the same principle of classification. Gagne (1964) suggested that some taxonomic levels differed in their content and not by formal characteristics affecting their condition of learning.

Validity Issues


Empirical testing of the cumulative hierarchical structure began shortly after the publication of Bloom's taxonomy (Kunen, Cohen, & Solman, 1981). Kropp and Stoker's (1966) study was considered the most comprehensive investigation of the validity of the cumulative hierarchical structure assumed by Bloom's taxonomy (Madaus, Woods, & Nuttall, 1973). On the basis of performance analyses of social science and science tests, Kropp and Stoker (1966) drew the conclusion that the empirical data generally supported the

In contrast to the simplex model approach used by Kropp and Stoker, (1966), a causal model approach was used by Madaus, Woods, and Nuttall (1973) to examine the validity of the cumulative hierarchical structure assumption of Bloom's taxonomy factoring in "g." The "g" factor was a measure of mental ability, and was considered because Ebel (1966, 1969a, 1969b) contended that mental ability, rather than command of knowledge, was measured by achievement tests constructed along the lines of Bloom's taxonomy.

Using Kropp and Stoker's (1966) data, Madaus, Woods, and Nuttall (1973), found that not only were indirect links between non-adjacent taxonomic levels reduced by the inclusion of the "g" factor, but also that the direct links between adjacent taxonomic levels were dependent on the "g" factor. Madaus, Woods, and Nuttall (1973), further reported that the direct links between the adjacent taxonomic levels at the lower end (Knowledge, Comprehension, Application, and Analysis) of the assumed hierarchy indicated a considerable reduction, and the direct links between Analysis to Synthesis and Synthesis to Evaluation became too weak to be retained in the model. In the concluding statements, Madaus, Woods, and Nuttall (1973) suggested that Synthesis and Evaluation may not be highly dependent on integration with the lower taxonomic levels.
Miller, Snowman, and O'Hara's (1979) findings supported the direct link of the first four lower taxonomic levels (Knowledge, Comprehension, Application, and Analysis) of Bloom's taxonomy found by Madaus, Woods, and Nuttall (1973). However, Miller, Snowman, and O'Hara (1979) found that a split occurred between the Analysis and Application taxonomic levels and between the Synthesis and Application taxonomic levels.

Further questioning the cumulative hierarchical structure of Bloom's taxonomy were Stedman (1973) and Ormell (1974). Stedman (1973) stated that there was a potential weakness to the cumulative hierarchical structure when he concluded that no significant differences were noted between the taxonomic levels of Knowledge and Comprehension or between Application and Analysis.

Stedman (1973) also concluded that the assumption that the taxonomic levels were arranged in a hierarchical structure was acceptable only if the taxonomy was viewed as progressing unevenly from low to higher levels of cognition. Similarly, Ormell (1974) found contradiction in the frequent inversion of various objectives and tasks, suggesting that certain demands for Knowledge were more complex than certain demands for Analysis or Evaluation.

Furst (1981) indicated that several authorities (Foley, 1971; McGuire, 1963; Ormell, 1974; Wilson, 1971) have considered Evaluation to be inherent in Synthesis and, therefore not superordinate. Empirical evidence (Kropp &
Stoker, 1966; Madaus, Woods, & Nuttall, 1973) also suggested that Evaluation should not be placed higher than Synthesis in the taxonomy, but at best, parallel with it.

In his concluding remarks, Seddon, (1978) wrote: "As a final assessment of the validity claims concerning the psychological properties of the taxonomy, it is perhaps fairest to say that the picture is uncertain. No one has been able to demonstrate that these properties do not exist. Conversely no one has been able to demonstrate that they do." (p. 321)

Despite the various concerns discussed, Bloom's taxonomy has offered a useful vehicle for examining teaching and learning (Fain & Bader, 1983). Miller (1989) indicated that concerns regarding the use of Bloom's taxonomy should be considered in light of the fact that it does not purport to be an all-inclusive, all-purpose tool.

Reliability Issues

Having considered the validity of Bloom's taxonomy as a cumulative hierarchical structure, attention should be given to the reliability of the taxonomy as a consistent indicator of cognitive behavior within and between studies (Miller, 1989). Pickford (1988) also indicated that if Bloom's taxonomy was to be an effective tool for communication between educators, then results obtained within and between observers and studies must be consistent.
In assessing reliability concerns, Clegg, Farley, and Curran, (1967), Stanley and Bolton, (1957), and Stoker and Kropp, (1964) found no significant differences between or among the taxonomic levels of Bloom's taxonomy made by observers. A study by Davis, Morse, Roberts, and Tinsley (1969) compared observer agreement in the previous studies. Davis et al. (1969) reported an inter-rater correlation coefficient of .85. Fairbrother (1975) supported the finding reported by Davis et al. (1969), while, Furst (1983) suggested that the inter-rater agreement decreased as the number of observers increased.

Fairbrother (1975) and Davis et al. (1969) found consistency in the use of Bloom's taxonomy by observers. Fairbrother (1975) also highlighted the problem of acceptable criteria upon which the subjects' cognitive abilities could be categorized. Additionally, Fain and Bader (1983) found that taxonomic levels were interpreted differently from study to study.

Davis et al. (1969) considered training to be a critical element in securing an acceptable reliability between observers. Pickford (1988) indicated that inter-rater agreement between and among observers of Bloom's taxonomy was closely linked to the training of observers, and suggested that "...where training was limited, inter-rater reliability is lower" (p. 20).
Related was the question pertaining to whether Bloom's taxonomy could be utilized across grades and subjects. Bloom et al. (1956), wrote that "it is assumed that essentially the same classes of behavior may be observed in the usual range of subject-matter content, at different levels of education" (p. 12). Kropp and Stoker (1966) supported the claim by Bloom et al. (1956) concluding that the taxonomy could be generalized across grades and subjects at least at the high school level, especially regarding the taxonomic levels of Knowledge and Evaluation. However, Furst (1981) questioned the validity to Bloom's et al. (1956) claim, suggesting that taxonomies were needed which were subject specific.

**Summary of Bloom's Taxonomy**

It would be difficult for a single hierarchical scheme to emerge as an all-inclusive, all purpose tool for the assessment of cognitive development without criticism. Cano (1988) suggested that there had not been any other classification system which had received as much attention from researchers and scholars regarding the validity of Bloom's taxonomy. While imperfect, Bloom's taxonomy does offer a useful method for categorizing the cognitive domain of thought.

In spite of the philosophical issues, validity and reliability issues presented, the use of Bloom's taxonomy remains widespread. Furst (1981) indicated that the Taxonomy of Educational Objectives, Handbook I: Cognitive Domain (Bloom...
et al., 1956) has had more than a million copies sold, been translated into several languages, used worldwide, and cited thousands of times. Miller (1989) indicated that "...the realization that no model for organizing cognitive behavior is without flaws, it appears that Bloom's taxonomy can serve as a solid foundation upon which research can be based" (p. 23).

Factors Related to Cognitive Development

Advancing cognitive development in students has been advocated by scholars (Dewey, 1944; Beyer, 1987; Bloom et al., 1956; Fischer & Grant, 1983; Piaget, 1970, 1973; Taylor & Dunbar, 1983). However, in advancing cognitive advancement, factors influencing cognitive development must be considered. Researchers (Cano, 1988; Pickford, 1988; Miller, 1989; Whittington, 1991) have identified several factors influencing cognitive development. The factors identified were instructional delivery, teacher-related factors, tests and assignments, and student-related factors.

Instructional Delivery

While ample research has been conducted in the preparation programs for teachers in the use of Bloom's taxonomy, only a small number of studies have been conducted which examined teaching strategies related to the cognitive development of students (Pickford, 1988). Research (Bane, 1969; Brown, 1968) has found a significant positive
association between teaching at higher levels of cognition and the teacher's fundamental philosophical beliefs.

Miller (1989) indicated that cognitive development took place in conjunction with formal instruction. Young (1982) suggested that the nature of the questions utilized during classroom learning had a dramatic effect on the students' ability to later utilize the information. Taba (1966) and Gall (1970) recommended that teachers should start a discussion by asking recall questions to test students' knowledge of facts and then ask higher cognitive questions beyond the recall of facts. Gall (1970) further hypothesized that follow-up questions of a student's response had great impact on student learning.

Hunkins (1968) found that teacher questions at the Evaluation and Analysis taxonomic levels of Bloom's taxonomy did produce significantly greater achievement scores in sixth graders than did questions in lower taxonomic levels. Hunkins' (1968) finding was supported by Ladd, (1969). Ladd (1969) used pretests and posttests to examine the effects of high-level questions and found that posttest scores were significantly correlated with the teacher's level of questioning.

However, the findings by Hunkins (1968) and Ladd (1969) were not supported by Rogers and Davis (1970). Rogers and Davis (1970) found that student achievement in groups taught by student teachers, using higher cognitive levels of
instruction, did not differ significantly from student achievement in the control group; noting that the treatment groups were taught only for a relatively short period of time.

A relationship between cognitive level of instruction and student achievement in social studies students was found by Ryan (1973, 1974). Ryan (1973) divided students into three groups for cognitive questions. One group received high-level questions, one received low-level questions, and the control group received no questions. Ryan (1973) found that the high-level and low-level question groups had significantly higher achievement scores on tests given immediately following the treatment, then the group without the use of questions. To determine the retention of performance, Ryan (1973) later posttested students. Ryan (1973) found that the students taught with the higher level questioning were better able to perform across all the levels of cognition than those who where taught using low cognitive level questions.

Ryan (1974) conducted follow-up studies to determine whether similar results would occur if questioning was used more extensively in both the high-level and low-level questions groups. Ryan (1974) found that both groups taught using questions, significantly outscored the group taught without the use of questions, both on the posttest and retention tests.

In a series of studies (Gall, 1970; Gall & Ward, 1978; Gall et al., 1976), the optimum cognitive level of questioning
was sought. The researchers found that student achievement was lower when teachers used 50% high cognitive level questions than when teachers used either 25% or 75% high cognitive level questions.

At the college level, Miller (1989) and Pickford (1988) investigated the relationship between cognitive level of discourse and the level of student performance. Pickford (1988), in her study of College of Agriculture undergraduate students, found a low positive relationship between cognitive level of teaching and the cognitive level of student performance. Similarly, Miller (1989) investigated College of Agriculture undergraduate students. However, Miller (1989) found a low negative relationship between student cognitive performance and the cognitive level of discourse.

In addition, McMillan (1987) found a pattern of impact for particular instructional methods or approaches after reviewing 27 studies on determinants of critical thinking ability in college. Similarly, Pascarella (1985) indicated that evidence suggested that higher cognitive level of thought could be positively influenced by instructional approach which maximizes student classroom involvement and participation at a relatively high level of cognitive activity.

Teacher-Related Factors

Miller (1989) indicated that the conflicting results pertaining to the degree to which teacher discourse affected student cognitive performance, sparked suspect of teacher
discourse as a factor that influenced student cognitive performance. Miller (1989) added that the complexity of teacher discourse affecting student cognitive performance was compounded when teacher discourse was not considered to be the only type of behavior which could influence teacher-impact on students.

Studies (Clegg, Farley, & Curran, 1967; Farley & Clegg, 1969) have found that teachers asked significantly more questions at higher cognitive levels when they had instruction in the knowledge and usage of Bloom's taxonomy than did teachers who had no instruction. Taba (1966) compared performance results of students instructed by teachers taught to use Bloom's taxonomy to guide classroom instruction to teachers not taught to use the taxonomy. Taba (1966) reported that the teachers taught to use Bloom's taxonomy, increased the number of higher levels of interaction, produced a greater number of ideas, and had ideas or units of thought that were greater in complexity. Taba (1966) further reported that teachers who were taught to use Bloom's taxonomy had classes that were generally superior to teachers not having been taught to use Bloom's taxonomy in ability to discriminate, infer from data, and apply principles to new situations.

Scholars such as Smith (1977), McKeachie, (1980), and Flander, (1970) have suggested teacher behaviors which attempted to invoke active involvement and student behaviors which were indicative of active involvement related to student
cognitive performance or critical thinking ability. Both McKeachie (1980) and Flanders (1970) found that more active involvement was associated with students performing at higher levels of cognition or critical thinking. In a study of 12 faculty members in a small liberal arts college, Smith (1977) found that teacher encouragement was positively associated with improved critical thinking.

Teachers' cognitive expectation has also been found to influence cognitive development. Pickford (1988) found that instructors with higher cognitive expectations provided students greater opportunity for higher cognitive achievement on both the final examination and on tests and assignments. Pickford (1988) also investigated instructors' previous experience as a factor influencing cognitive development. Pickford (1988) found a substantial negative relationship between instructor's previous experience and students' cognitive level of achievement, but cautioned the reader in the interpretation because of confounding influences of the exams.

Other possible teacher-related factors which have been suggested to influence student cognitive development include: classroom climate (Anderson, 1970; Walberg & Anderson, 1968), amount of classroom discussion (Gall et al., 1970, 1976, 1978), sequence and types of questions (Ryan, 1973, 1974), student-centered versus teacher-centered instruction (McKeachie & Kulick, 1975; Pickford, 1988), and teacher
behaviors such as clarity, variability, enthusiasm, business-like-behavior, and opportunity to learn the criterion material (Rosenshine & Furst, 1971).

Tests and Assignments

Tests and assignments is another factor influencing cognitive development in students. Milton (1982) argued that test items and cognitive levels of tests influenced student learning. Milton (1982) indicated that test items at the college level represent 95% recall items.

Whittington's (1991) finding supported Milton's (1982) results. Whittington (1991) investigated College of Agriculture faculty and found that 80% of college instructors' tests items represented the lower levels of cognition. Whittington's (1991) results also supported Miller's (1989) findings. Miller (1989) found that two-thirds of the items appearing on tests and quizzes given by College of Agriculture instructors were at the Knowledge and Comprehension levels of cognition. In addition, studies by Pickford (1988) and Miller (1989) found a positive relationship between the cognitive level of tests and assignments and college students' level of cognitive performance.

Using a modification of Bloom's taxonomy, Newcomb and Trefz (1987) investigated instructors in the College of Agriculture to determine the level of cognition of tests and student assignments at various course levels. Newcomb and Trefz (1987), supported by Whittington (1991) and Miller
(1989), concluded more learning at the remembering (Knowledge and Comprehension) level in lower division courses and more learning at the processing (Application and Analysis) level in the upper division courses.

In addition, Newcomb and Trefz (1987) concluded limited learning at the creating (Synthesis) and Evaluation levels for either course division. Newcomb and Trefz (1987) also concluded that in both the upper and lower division courses, when instructors included laboratories, homework, individual and group projects, and term papers, more learning was found at the higher levels of cognition. Miller (1989) supported Newcomb and Trefz's (1987) findings that assignments given by instructors were more likely to require students to apply, analyze, synthesize and evaluate information than tests, quizzes, or in-class discourse.

**Student-Related Factors**

While instructional delivery, teacher-related factors, and tests and assignments hold to be very important influential factors affecting cognitive development, student-related factors may be more profound. Students' background, intelligence, and motivation appear to be important factors in the cognitive development of students (Kropp & Stoker, 1966; Roberts, 1974; McKeachie, 1980; Miller, 1989; Pickford; Pintrich, 1988; Taylor & Dunbar, 1983).

The cognitive ability of students has been found to be associated with performing at various levels of cognition.
Kropp and Stoker (1966) found links between general ability (which includes intelligence) and all levels of Bloom's taxonomy. However, Kropp and Stoker (1966) stated that the links became weak between the Synthesis and Evaluation levels and cognitive ability. Nonetheless, Roberts (1974) found that IQ was not a significant determinant of higher levels of cognition.

While students' cognitive ability plays an important role in performing at various levels of cognition, McKeachie (1980) maintained that students' background probably was more important than students' level of intelligence in performing. However, McKeachie's (1980) claim was not supported by Lawrence (1987). Lawrence (1987) found students' prior experience in working with horses had no effect on their performance in a horse management class.

Student motivation is yet another student-related factor influencing cognitive development. Pintrich (1988) suggested that initial acquisition of knowledge and transfer of cognitive skills across cognitive domains required students to be motivated. Pickford (1988) found a substantial positive relationship between students' cognitive level of achievement and interest in and value of the course enrolled. Miller (1989) found a low positive association between students' cognitive performance and motivation.
Other Factors Influencing Cognitive Development

While many factors have been identified, several other factors may influence cognitive development in students. Fischer and Grant (1983) and McKeachie and Kulick (1975) reported that smaller classes at the college level were associated with greater use of higher levels of cognition. Fischer and Grant (1983) also found larger college institutions to be associated with higher levels of cognition. Chickering (1972) suggested that higher levels of cognition were effected by major elements of the environment (mental activities in class, mental activities while studying for courses, reasons for studying, feelings about courses, patterns of work, and role of the teacher).

Whittington (1991) cited literature to suggest that factors such as class attendance, keeping up with reading assignments, and hours per day spent studying influence attainment of higher cognitive levels. Additionally, student attributes such as ethnicity, gender, age, socioeconomic status, level of secondary school preparation, personality traits, and educational/occupational aspiration may be worth considering in terms of the influence of college learning and cognitive development (Pascarella, 1985).

Summary of Cognitive Development Research

Several factors have been identified by research to positively influence students' development at the various levels of cognition. Teachers' philosophical beliefs,
preparation, and cognitive expectation of students, influence students' cognitive developments as do the types and levels of questioning used in classroom discussion. The type and cognitive levels of tests and assignments also influence students' cognitive development.

Additionally, students' classroom involvement, motivation, background, and intelligence, have been suggested to influence student cognitive development. Furthermore, students' attributes such as ethnicity, gender, age, socioeconomic status, level of secondary school preparation, personality, and educational aspiration have been identified as viable factors in students' cognitive development.

**Gender Differences in Cognitive Ability**

Thurstone and Thurstone (1941) found that scores on several cognitive ability tests given to eighth grade students formed three sets of clusters which they called verbal, number (quantitative), and perception (spatial) factors. Verbal, quantitative, and spatial factors are the three cognitive ability factors in which gender differences were most frequently reported (Halpern, 1986). Cognitive ability tests attempt to assess the likelihood of one's capability to succeed at certain tasks in the future if proper instruction is received and one is motivated to learn and demonstrate the skill needed to perform the task (Halpern, 1986). Halpern (1986) provided a comprehensive review and synthesis of the
research and theories that pertained to the questions of cognitive differences in gender.

The cognitive ability females and males develop depend on many variables. Halpern (1986) suggested that cognitive abilities were likely influenced by many variables (age, birth order, cultural background, socioeconomic status, gender role orientation, learning histories). A host of sociodemographic (age, place of residence), psychological (motivation), biological (health status), and life history (level of education) variables operate in conjunction with gender to determine the level of each cognitive ability that an individual obtained (Halpern, 1986).

Unlike physical abilities, cognitive abilities do not remain static across the span of one's life (Halpern, 1986). Different activities follow their own developmental course, reflecting the influences of age-dependent biological and sociological changes (Halpern, 1986)

Maccoby and Jacklin (1974) reviewed more than one thousand research reports on gender differences. Maccoby and Jacklin (1974) identified three cognitive abilities and one personality variable in which gender differences were "fairly well established" (p. 351). The three cognitive abilities that were identified as the loci of gender differences were verbal, quantitative, and spatial ability.
Verbal Abilities

Evidence from a variety of sources supported the finding that, on the average, females had better verbal abilities than males (Halpern, 1986). Females aged 1 to 5 years old were more proficient in language skills than their male counterparts (McGuiness, 1979). In general, the evidence for female superiority in verbal ability tended to support the idea that females were more verbally precocious than males (Halpern, 1986). Halpern (1986) stated that "although verbal gender differences favoring females in early childhood may be somewhat tenuous, they emerge clearly at adolescence and continue into old age" (p. 47).

Wechsler (1955) found that during the middle childhood years (age 6 to 11) there was no consistent gender difference in the verbal subscores; however, females age 16 to 64, obtained higher mean scores on the verbal subtests of the Wechsler IQ test than similar age males. In addition, gender differences in verbal ability were commonly found in the American College Test (ACT) and Scholastic Aptitude Tests (SAT) used for college admission (Burnett, Lane, & Dratt, 1979).

Quantitative Abilities

"There is little doubt that females score differently from males on mathematical tests" (Plake, Loyd, & Hoover, 1981, p. 780). The findings that "males outperform females in
tests of quantitative or mathematical ability is robust" (Halpern, 1986, p. 57).

Males tend to outscore females on the quantitative portions of the SAT and have an advantage on the highly standardized test of approximately 50 points (Burnett, Lane, & Dratt, 1979). The developmental nature of quantitative gender differences was examined in a recent study of over 5,000 students age 13 to 17. No gender differences were found for the 13 year-olds, whereas by age 17, the males were significantly outperforming the females with an average of 5% more correct answers (Jones, 1984).

Hilton and Berglund (1974) indicated that gender differences in quantitative abilities emerged earlier for males and females pursuing an academic curriculum, than for students in a nonacademic course of study. Halpern (1986) concluded that "while the preponderance of the experimental evidence points to [gender] differences in verbal, spatial, and quantitative ability, the question of the size or magnitude of these differences has not been easy to resolve" (p. 60).

**Spatial Abilities**

The term "spatial abilities" refers to the ability to imagine what an irregular figure would look like if it were rotated in space, or the ability to discern the relationship among shapes and objects (Halpern, 1986). The possibility exits that spatial ability differs as a function of ethnicity
or race (Mandler & Stein, 1977). In a review of the literature on race differences in perceptual functioning, Mandler and Stein (1977) concluded that there could be a visualization factor involving rotations or transformations of shapes that differed among ethnic groups.

In a review of literature on gender differences in spatial abilities, McGee (1979) concluded that male superiority on tasks requiring spatial abilities was among the most persistent of individual differences in all the abilities literature. Maccoby and Jacklin (1974) concluded that spatial ability gender differences did not emerge until adolescence. Gender differences in spatial abilities were consistently reported from adolescence into old age (Halpern, 1986). Furthermore, there was evidence of a gender and age interaction such that spatial abilities declined more in older females than older males (Elias & Kinsbourne, 1974).

**Summary of Gender Differences**

Gender differences were reported with a female advantage in verbal abilities and a male advantage in spatial and quantitative abilities. In general, verbal ability differences between gender were small in magnitude, spatial ability differences were large, and quantitative ability differences were intermediate.
Summary of Cognitive Ability

In his review of higher education literature, Pascarella (1985) indicated that there was substantial evidence in the literature to support the contention that students typically "knew" more when they left college as seniors than they when entered as freshmen. There was additional evidence (Lehmann, 1963; Keeley, Browne, & Kreutzer, 1982) to suggest that cognitive gains were not limited to increases in academic knowledge, but the ability to think abstractly and to discriminate among abstractions (Mentkowski & Strait, 1983).

Miller (1989) indicated that "unfortunately, much of the research that has been done on cognitive level of instruction indicates that a preponderance of oral presentation by teachers as well as the textbooks and examinations associated with instruction typically reflect thinking at the lower levels of cognition (Knowledge, Comprehension, Application)" (p. 24).

Learning Style

Behavioral scientists and educators have long known that teaching is more effective when individual differences in students' prior knowledge and level of cognitive development is taken into account (Messick, 1976). As early as 334 B.C., Aristotle said that "each child possessed specific talents and skills and discussed the concept of individual differences in young children" (Osborn, 1975, p. 8).
Examining the literature on individual student differences, Corno and Snow (1986) concluded that the major differences involved cognitive abilities, personality characteristics, and learning styles. Messick (1976) indicated that "we must move beyond the differences in content and level of learning to more subtle differences in the process of cognition" (p. vi). The "differences in the process of cognition" Messick (1976) referred to was learning style. Elaborating, Messick (1970) stated that there were several dimensions of individual differences in the process of cognition; distinct from the context of cognition on the level or skill displayed in the cognitive performance.

The ensuing review of literature focuses on the definition of learning style, distinctions between learning style and cognitive abilities, and types of learning styles. Additionally, literature centers on field dependence/independence instruments, determinants of learning style, characteristics of field dependence/independence, factors related to learning style, and gender differences in learning style.

Learning Style Defined

Many researchers and scholars (Cano, 1993; Claxton & Ralston, 1978; Cross, 1976; Garger & Guild, 1984; Gregorc, 1979; Keefe, 1979; Kogan, 1971; Messick, 1970, 1976; Vernon, 1973; Witkin, 1976) have described and given learning style
several definitions. Messick (1970) indicated that learning style represents "a person's typical mode of perceiving, remembering, thinking, and problem solving" (p. 188) and there were constant individual differences in ways of organizing and processing information and experiences (Messick, 1976).

Kogan (1971) directly defined learning style as "an individual's variation in modes of perceiving, remembering, and thinking, or as distinctive ways of apprehending, storing, transferring, and utilizing information" (p. 244). After reviewing various uses of the term, Vernon (1973) defined learning style as "a superordinate construct which is involved in many cognitive operations, and which accounts for individual differences in a variety of cognitive, perceptual, and personality variables" (p. 141).

Witkin (1976) defined learning style as cognitive modes of functioning that a person revealed throughout his/her perceptual and intellectual activities in a highly consistent and pervasive way. Similarly, Cross (1976) defined learning style as characteristic ways of the mind.

Learning style was defined by Claxton and Ralston (1978) as a student's consistent way of responding to and using stimuli in the context of learning. Gregorc (1979) described learning style as "consisting of distinctive behaviors which serve as indicators of how a person learns from and adapts to his/her environment. It also give clues as to how a person's mind operates" (p. 234).
Furthermore, Keefe (1979) referred to learning style as "characteristic cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (p. 4). Garger and Guild (1984) indicated that learning style were stable and pervasive individual characteristics expressed through the interaction of one's behaviors and personality as one approaches a learning task.

Most recently, Cano (1993) defined learning style as a consistent pattern of behavior and performance by which an individual approached an educational experience. For the purposes of this document, Cano's (1992) definition of learning style will be adopted for use.

**Distinctions Between Learning Style and Cognitive Abilities**

Messick (1976) carefully distinguished between learning style and cognitive abilities in a number of ways. Messick (1976) indicated that cognitive ability dimensions essentially referred to the content of cognition or the question of "what" -- "what kind of information is being processed by what operation in what form?" (p. 7). Learning style, in contrast, addresses the question of "how" -- on the manner in which the behavior occurs.

The concept of cognitive ability implies the measurement of capacities in terms of maximal performance, with emphasis upon level of accomplishment, whereas the concept of style
implies the measurement of characteristic modes of operations in terms of typical cognitive performance, with the emphasis upon process. Furthermore, abilities are generally thought of as unipolar, varying from zero or very little to a great deal, with increasing levels implying more and more of the same facility. Conversely, learning styles are typically bipolar, ranging from one extreme to an opposite extreme, each end of the dimension having different implications for behavior (Messick, 1976).

Another way Messick (1976) distinguished between learning style and cognitive ability was in the value usually conferred upon them. Cognitive abilities are value directional; having more of an ability is better than having less. Learning styles are value differentiated; each pole having adaptive values in different circumstances.

Learning styles also differ from cognitive abilities in their breadth of coverage and pervasiveness of application (Messick, 1976). An ability usually delineates a basic dimension underlying a fairly limited area, such as verbal, quantitative, or spatial. Learning style, in contrast, cut across domains in such processes as problem solving and learning.

One other difference between learning style and cognitive ability identified by Messick (1976) was in the method by which measurement was obtained. Cognitive abilities are rooted in mental theories and have had close ties with
education since the beginning of the century. Instruments used to measure cognitive abilities have typically taken the form of paper-and-pencil tests. Learning styles, in contrast, are rooted in the study of perception and personality. Learning style measurements were closely tied to laboratories and clinics with exceptions consisting of paper-and-pencil instruments.

**Learning Style Types**

In a discussion of various types of learning styles, Messick (1970) identified nine styles. The nine learning styles included:

1. Scanning: a dimension of individual differences in the extensiveness and intensity of attention deployment, leading to individual variations in the vividness of experience and the span of awareness.

2. Breadth of categorizing: consistent preferences for broad inclusiveness, as opposed to narrow exclusiveness, in establishing the acceptable range for specified categories.

3. Conceptualizing styles: individual differences in the tendency to categorize perceived similarities and differences among stimuli in terms of many differentiated concepts, which is a dimension called conceptual differentiation, as well as consistencies in the utilization of particular conceptualizing approaches as
bases for forming concepts (such as the routine use of concept formation of thematic or functional relations among stimuli as opposed to the analysis of descriptive attributes or the inference of class membership).

4. Cognitive complexity vs. simplicity: individual differences in the tendency to construe the world, and particularly the world of social behavior, in a multi-dimensional and discriminating way.

5. Reflectiveness vs. impulsivity: individual consistencies in the speed with which hypotheses are selected and information processed, with impulsive subjects tending to offer the first answer that occurs to them, even though it is frequently incorrect, and reflective subjects tending to ponder various possibilities before deciding.

6. Leveling vs. sharpening: reliable individual variations in assimilation in memory. Subjects at the leveling extreme tend to blur similar memories and the merge perceived objects or events with similar but not identical events recalled from previous experience. Sharpener, at the other extreme, are less prone to confuse similar objects and, by contrast, may even judge the present to be less similar to the past than is actually the case.

7. Constricted vs. flexible control: individual differences in susceptibility to distraction and cognitive interference.
8. Tolerance for incongruous or unrealistic experiences: a dimension of differential willingness to accept perceptions at variance with conventional experience.

9. Field independence vs. field dependence: an analytical, in contrast to global, way of perceiving which entails a tendency to experience items as discrete from their backgrounds and reflects ability to overcome the influence of an embedding context.

Little literature was found on eight of the nine learning styles outlined by Messick (1970). However, a review of literature suggested that two learning styles have gained prominence in the field of education. The two learning styles identified were: Kolb's learning style based on Lewin's cycle of experiential learning and Witkin's learning style based on the field dependence/independence dimension.

Kolb's Learning Style

In 1976, Kolb developed his original version of the Learning Style Inventory (LSI) to measure individual learning styles derived from the experiential learning theory. Ash (1986) indicated that Kolb's experiential learning theory was so called because the term had historical origins in the social psychology of Lewin in the 1940's and sensitivity instruction in the 1950's.

Kolb (1981) indicated that in the learning process, experience played in a major role. Kolb (1981) suggested that experience as a major role in the learning process was an
emphasis that differentiates his approach from other cognitive theories of the learning process. A description of Kolb's learning style theory was presented by Williams (1980):

"...[Kolb] conceptualizes learning as a four-stage process. The first stage, concrete experience, is followed by observations and reflections. This leads on to the formation of abstract concepts and generalizations which should be followed by testing the implications of concepts in new situations. This then leads into a further cycle of new experiences and so on." (p. 389)

The LSI was designed to measure an individual's emphasis on four learning abilities. Kolb (1976) identified the four learning abilities as Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE). In addition to the four learning abilities, two combination scores indicated the extent to which an individual emphasized abstractness over concreteness (AC-CE) and the extent to which an individual emphasized action over reflection (AE-RO) (Kolb, 1976).

The LSI assessed students' overall learning preference based on the students' subject major (Tamaoka, 1985). The LSI also measured an individual's strengths and weaknesses as a learner. Kolb (1981) categorized the styles identified by the LSI as Converger, Diverger, Assimilator, and Accommodator.
Kolb (1981) described the Converger style as the following:

"Convergers' dominant learning abilities are Abstract Conceptualization and Active Experimentation. Their greatest strength lies in the practical application of ideas. ...persons with this style...do best in those situations, like conventional intelligence tests... These persons organize knowledge in such a way that...they can focus it on specific problems... They tend to have narrow interests and often choose to specialize in the physical science." (p. 238)

Individuals having a Diverger style were described by Kolb (1981) as:

"...best at Concrete Experience and Reflective Observation. Their greatest strength lies in imaginative ability. They excel in the ability to view concrete situations from many perspectives and to organize many relationships into a meaningful "gestalt." ...persons of this type perform better in situations that call for generation of ideas, such as [in] "brainstorming" sessions. Diversers are interested in people and tend to be imaginative and emotional... Counselors, organization development consultants, and personnel managers often have this learning style." (p. 238)
Assimilators style is described as individuals whose: "...dominant learning abilities are Abstract Conceptualization and Reflective Observation. Their greatest strength lies in the ability to create theoretical models. They excel in inductive reasoning, in assimilating disparate observations... They are less interested in people and more concerned with abstract concepts, but less concerned with the practical uses of theories. ...this learning style is more characteristic of the basic sciences and mathematics than of the applied sciences." (Kolb, 1981, p. 238)

In conclusion, the Accommodator style outlined by Kolb (1981) suggested individuals:

"...are the best at Concrete Experience and Active Experimentation. Their greatest strength lies in doing things...and becoming involved in new experiences. They tend to be risk takers. ...persons with this style tend to excel in situations that call for adaptation to specific immediate circumstances... They tend to solve problems in an intuitive trial-and-error manner... Accommodators are at ease with people, but are sometimes seen as impatient and "pushy." Their educational backgrounds are often technical or practical fields such as business. ...people with
this learning style are found in "action-oriented" jobs, often in marketing or sales." (p. 238)

Because of several criticisms, a revised version of the LSI was developed in 1985. Criticisms specific to the original version of Kolb's (1976) LSI revolved around its brevity and resulting lack of reliability (Moore & Sellers, 1982), the ambiguity of individual words (Wunderlinch & Gjerde, 1978), and the lack of correlation with statements taken from Kolb's descriptions (Fox, 1984). Additionally, response options were always presented in the same order, increasing possibility of response set (Kirby, 1979).

Kolb's (1985) new version of the LSI dealt with the problems identified in the original version regarding its brevity and ambiguous wording by adding six new items per scale and revising the items into simpler language (Rule & Grippin, 1988). However, Kolb's (1985) new LSI version did not address the problem of item format and use of norms (Bonham, 1988). In addition, because the revised LSI version was relatively new, Bonham (1988) indicated that it lacked a history of reliability and validity.

Field Dependence and Independence

Herman A. Witkin, often called the father of learning styles (Kirby, 1979), whose work "is the most extensive and indepth research on cognitive [learning] styles conducted in the last 50 years" (Guild & Garger, 1985, p. xii), focused on field dependence and independence dimension of learning.
styles. The field dependence/independence dimension has had the widest application to educational problems (Witkin, Dyk, Faterson, Goodenough, & Karp, 1962, 1974; Witkin, Lewis, Hertzman, Machover, Meissner, & Wapner, 1954, 1972; Witkin, 1976; Witkin, Moore, Goodenough, & Cox, 1977a; Witkin, Moore, Goodenough, Friedman, Owen, & Raskin, 1977b).

Witkin's interest in learning styles dated back to 1942, when he studied factors related to perception of the upright (Witkin et al., 1954). Witkin coined the well-known terms "field dependent" and "field independent" (Kirby, 1979).

The field dependence/independence dimension is a bipolar continuum, in the sense of not having a clear high or low end. The bipolar feature makes field dependence/independence value neutral (Witkin et al., 1977b). Witkin et al. (1977b) added that subjects at each end of the dimension were high in some characteristics and low in others, where by being located at the field dependent pole or field independent pole was not inherently better or worse.

Field dependence versus field independence refers to a consistent mode of approaching the environment in global, as opposed to analytical terms (Messick, 1976). Witkin and his associates (Witkin et al., 1954; Witkin et al., 1962; Witkin, Oltman, Raskin, & Karp, 1971; Witkin, 1976; Witkin et al., 1977a, 1977b) indicated that the field dependence/independence dimension denoted two opposite tendencies. One tendency was to experience events globally in an undifferentiated fashion.
The opposite tendency was to articulate figures as discrete from their backgrounds and a facility to differentiate objects from embedded context. Claxton and Ralston (1978) cautioned that research on field dependence and independence did not mean to imply that there were two types of persons, rather a person's standing on the dimension was described by their position relative to the mean.

Witkin's work in field dependence/independence was considered important to higher education for two reasons. The first reason of importance was that Witkin's work had major implications for researchers and theoreticians interested in understanding how varied institutional environments and education practices influenced the cognitive and affective development of college students (Chickering, 1976). The second reason of importance to higher education was that field dependence/independence had major implications for college admissions and faculty members who made decisions about those environments and practices (Chickering, 1976).

Field dependence/independence dimension as a measure of learning style was used in this study. Field dependence/independence was particularly useful for understanding learning styles and hence improving teaching for many reasons: students and teachers could be easily assessed for their preferred style; field dependence/independence was well accepted - almost 4,000 studies have been conducted on the subject (Morgan, 1985); field dependence/independence could be
applied cross culturally (Ramirez & Castaneda, 1974); and finally, once understood, field dependence/independence dimension could be easily incorporated into classroom instruction.

Thompson, Finkler, and Walker (1979, p. 9) found that, of several learning style measures, "only the GEFT [Group Embedded Figures Test, an instrument that measures field dependence/independence] appeared to demonstrate consistent and meaningful relationships across schools and time to such academically important outcomes as choice of major, interest in various disciplines, cumulative GPA, hours taken, and cumulative GPA in science."

Field Dependence/Independence Instruments

Over the years, Witkin and his associates (Witkin et al., 1954; Witkin et al., 1962; Witkin et al., 1971; Witkin, 1976; Witkin et al., 1977a, 1977b) have developed and used a variety of instruments to measure the field dependence/independence dimension. Assessment of field dependence/independence has its origin in the laboratory. Later, paper-and-pencil tests were developed.

Some assessment tests have been developed for use in individual settings and others for administration in group settings. Tests developed for individual testing were the Tilting-Room-Tilting-Chair tests (TRTC), Rotating Room Test (RRT), Rod-and-Frame-Test (RFT), and the Embedded Figures Test
(EFT). The Group Embedded Figures Test (GEFT) was designed for group administration with versions for preschoolers, children, and adults.

Tilting-Room-Tilting-Chair tests consists of a Room Adjustment Test (RAT) and Body Adjustment Test (BAT). For the RAT and BAT, a subject is seated in a chair that is suspended in a specially designed room where both room and chair may be tilted left or right.

In the Room Adjustment Test (RAT), both the room and chair are tilted. With the chair remaining in its tilted position, the subject's task is to instruct the examiner to reorient the room to the upright position. The RAT is comprised of eight trials; in four trials the room and chair are tilted in the same direction, and in four trials the room and chair are tilted in opposite directions.

The Body Adjustment Test (BAT) consists of six trials. In half the trials the room and chair are tilted in the same direction, and in the other half they are tilted in opposite directions. While the room remains tilted, the subject is required to direct the examiner to bring him/her to the upright position.

The Rotating Room Test (RRT) separates the visual and kinesthetic standards for uprightness by modifying the pull of gravity through the centrifugal force created by the rotating motion of the room. The subject, while seated in a chair which could be adjusted to various angles of uprightness, was
rotated around a track from which an upright room is viewed. The subject's task was to adjust his/her body to what he/she considered the true upright position.

The Rod-and-Frame-Test (RFT) was the major instrument used in early research by Witkin and his associates (Goldstein & Blackman, 1978). The subjects who took the RFT were seated in complete darkness and viewed a luminous rod suspended within a luminous frame. Both rod and frame were tilted independent of each other. Initially, the rod and frame were both tilted, and the subject was asked to direct the examiner to adjust the rod to a position that the subject believed was vertical while the frame around it remained in its original position of tilt. The standard administration of the RFT consists of three series of eight trials each. In the first series, the frame and the subject's body are both tilted in the same direction; the rod is tilted in the same or opposite direction. The subject's task is to bring the rod to a vertical position. In the second series of trials, the subject's body and the frame are both tilted in opposite directions. In the third series of tasks, the subject remains erect while the frame is tilted to the right or left. The three standard scores are averaged to produce an overall score. However, Witkin et al. (1962) suggested using only the third series of the RFT instead of the complete test.

The Embedded Figures Test (EFT) is a perceptual paper-and-pencil test of geometric shapes. Although the EFT does
not involve perception of the upright or the body, it is quite similar to the RFT and TRTC tests in its essential perceptual structure.

In the EFT, subjects are shown a simple geometric figure. The simple geometric figure is then removed requiring the subject to locate the simple figure within a complex context. Witkin selected 24 figures from a set originally developed by Gottschaldt (Witkin et al., 1954) and superimposed colored patterns to make the task more difficult. The subject was originally given a maximum of five minutes for each figure. For research purposes, Witkin et al. (1962) recommended the use of the first 12 items of the EFT, with a three-minute limit for each item.

As with the TRTC tests, the RRT, and the RFT, a positive quantitative score is indicative of field dependence or independence. The quantitative score is derived from the extent to which the subject's perception of an item had been influence by the organized field surrounding it.

While several measures of field dependence/independence are available, the most widely used measure has been the Group Embedded Figures Test (GEFT) (Witkin et al., 1971). The GEFT is similar to the EFT, but was designed for adult group administration with versions for preschoolers (ages 3-5), and children (ages 5-10). The GEFT contains 18 complex figures, 17 of which were taken from the EFT. Three sections comprise the GEFT: the first section contains seven simple geometric
figures and is for practice purposes. The second and third sections, each contain nine more difficult geometric figures. The two sections are scored by summing together the number of the 18 items on which the subjects correctly located the hidden geometric figure within a more complex figure. The GEFT is a timed test requiring 20 minutes for administration.

The common denominator underlying individual differences in performance in the various tasks previously mentioned, is the extent to which the subject is able to deal with a part of a field separately from the field as a whole, or the extent to which the subject is able to disembed items in the field (Witkin et al., 1977a). At one extreme of the performance range, perception is strongly dominated by the prevailing field. The mode of perception which is strongly dominated by the surrounding field was designated "field dependent." At the other extreme, the subject experiences items as more or less separate from the surrounding field. The designation for the mode of perception which is relatively uninfluenced by the surrounding field is "field independent" (Witkin et al., 1977a).

Additionally, because the scores from any test of field dependence/independence form a continuous distribution, the labels reflect a tendency, in varying degrees of strength, toward one mode of perception or the other (Witkin et al., 1977a). Repeating Claxton and Ralston's (1978) caution, research on field dependence/independence did not mean to
imply that there were two types of persons, rather, a person's standing on the field dependence/independence dimension was described by their position relative to the mean.

The Rod-Adjustment Test (RAT), Body-Adjustment-Test (BAT), Rotating Room Test (RRT), Rod-and-Frame-Test (RFT), Embedded Figures Test (EFT) and the Group Embedded Figures Test (GEFT) with its versions for preschoolers, children, and adults have all been shown to be valid and have good reliability (Evans, 1969; Fenchel, 1958; Gardner, 1961; Gardner, Jackson, & Messick, 1960; Goodenough & Karp, 1961; Kipperman, 1964; Linton, 1952, 1955; Oltman, 1964; Witkin, 1948, 1949; Witkin & Asch, 1948; Witkin et al., 1954; Witkin et al., 1962; Witkin et al., 1971; Witkin, 1976; Witkin et al., 1977a, 1977b; Zuckerman, 1968).

While field dependence/independence instruments have had a successful history of measuring field dependence/independence, some weaknesses in using the EFT and the GEFT have been identified. Shipman and Shipman (1985) and Witkin and Goodenough (1981) suggested that the ability to do something was being measured, not the manner (style) in which the task was done. Only one ability was being measured (field independence) and the presence of the opposite ability (field dependence) was only implied by relative absence of the one being measured (Shipman & Shipman, 1985; Witkin & Goodenough, 1981). There was no way to tell whether a person was good at both approaches and could consequently choose whichever style
was most effective in a given situation; or even whether the traits were true opposites (Shipman & Shipman, 1985; Witkin & Goodenough, 1981).

In addition, the disembedding task of the EFT and GEFT was commonly agreed to be a measure of spatial abilities (Shipman & Shipman, 1985; Witkin & Goodenough, 1981), and females generally did not do as well as males on tests of spatial ability (Maccoby, 1966; Maccoby & Jacklin 1974). Bonham (1988) indicated that because field dependence/independence was said to be a broad psychological trait, men and women could accurately be compared on the trait if the trait was measured by a task that was gender-biased. Thus, Bonham (1988) suggested that men should be measured only against other men, and women against women, to reduce the differential effect of field dependence/independence on the genders.

**Determinants of Learning Styles**

It appears that the early experiences children have with their mother are important in determining learning styles (Claxton & Ralston, 1978). Studies of the family experience of children who become relatively field dependent or field independent have demonstrated that the kind of relations the child had with his/her mother was very influential in determining his/her learning style (Dyk, 1969; Dyk & Witkin, 1965; Seder, 1957; Witkin et al., 1962).
Witkin (1976) indicated that the characteristic of child rearing that seemed most closely associated with the development of a more field independent style, was the early encouragement of autonomous functioning. However, autonomous functioning in child rearing was not always related to the child's level of field independence (Goodenough & Witkin, 1977).

Socialization experiences also appeared to be important in determining learning style. In reviewing cross-cultural studies of field dependence/independence, Witkin (1976) concluded that the parent-child interactions were associated with cultures. For example, Ramirez and Price-Williams (1974) found White subjects to be more field independent than subjects who were Hispanic or African American.

Genetic factors, to a much smaller degree, also seemed to have implications in determining field dependence/independence. Witkin (1976) indicated gender differences in field dependence/independence had been found (a specific section is devoted to gender difference).

Characteristics and Behaviors of Field Dependence

Many researchers and educators (Cano, 1993; Garger & Guild, 1984; Claxton & Ralston, 1978; Reiff, 1992; Saracho, 1989; Witkin et al., 1954; Witkin et al., 1962; Witkin et al., 1971; Witkin, 1976; Witkin, et al., 1977a, 1977b) have identified characteristics and behaviors of field dependent
and field independent persons. Persons who are heavily influenced by the surrounding field are called "field dependent" and are said to be globally oriented (Cano, 1993; Garger & Guild, 1984; Claxton & Ralston, 1978; Reiff, 1992; Witkin, et al., 1977a, 1977b).

Garger and Guild (1984) indicated that field dependents made broader general distinctions among concepts and were better able to see relationships. Field dependents were also unable to "break up" major tasks into smaller tasks becoming quickly frustrated (Cano, 1993; Witkin et al, 1977a, 1977b). Because of the field dependents' difficulty in "breaking down" major tasks, field dependents are said to be poor analytical problem solvers (Cano, 1993; Witkin et al., 1977a, 1977b).

Experiencing more difficulty performing problem-solving functions, field dependents tend to "give up" quickly and become uninterested in the task requiring a high level of problem-solving skill (Cano, 1993). The struggle field dependents experience with an analytical task does not suggest they can not do math or science, rather they probably have a more difficult time when challenged by these subject areas (Cano, 1993).

Social contexts and orientations are preferred by field dependents. Field dependents are prone to be influenced by authority figures and by peer groups (Cano, 1993; Witkin, 1976; Witkin, et al., 1977a, 1977b). Reflecting their use of external sources of information for self definition, field
dependents are selectively attentive to the human context of the environment (Cano, 1993; Witkin, 1976; Witkin et al., 1962).

Thus, field dependents literally spend more time looking at the faces of those with whom they interact, which serves as the primary source of information about what others are feeling and thinking (Claxton & Ralston, 1978; Witkin, 1976; Witkin et al., 1977a, 1977b). In addition, Witkin et al. (1977a) indicated that field dependents attended more to verbal messages with social content. Witkin et al. (1977a) noted that field dependents have "what in effect amounts to a sensitive radar system, selectively attuned to social components of the environment" (p. 10).

Witkin et al. (1977a) indicated that in addition to being sensitive to social cues, and interested in what others have to say and do, field dependents were drawn to people and preferred to be physically close to others. Cano (1993) indicated that field dependents generally gave social environment priority over the learning environment and found it easier to want to "socialize" with their peers, rather than become involved in the learning process.

With regard to learning, field dependents learn best with a social content, attend best to the learning material relevant to their own experiences, and require externally defined goals and reinforcements (Garger & Guild, 1984; Reiff, 1992). Witkin et al. (1977a) indicated that, in the learning
process, field dependents preferred the spectator approach to concept attainment and required instruction to have structure and organization. Field dependents need more explicit instruction in problem-solving strategies and exact definition of performance outcomes (Witkin, 1976; Witkin et al., 1977a, 1977b).

Field dependents seek guidance, modeling, opinions in making decisions, and rewards from the instructor (Cano, 1993; Garger & Guild, 1984; Reiff, 1992; Saracho, 1989; Witkin, 1976). Cano (1993) also suggested that because of their instinct for socialization, field dependents were motivated extrinsically, and through verbal praise and grades. Furthermore, field dependents require externally defined goals and reinforcement and are sensitive to criticism (Cano, 1993; Garger & Guild, 1984; Witkin et al., 1977a).

Characteristics and Behaviors of Field Independence

Field independents tend to have characteristics and behaviors that are direct opposites of the field dependents. Field independents are not heavily influenced by the surrounding field and tend to perceive analytically (Cano, 1993; Garger & Guild, 1984; Reiff, 1992; Witkin, 1976; Witkin et al., 1977a, 1977b). Because of their analytical ability, field independents tend to do better in subjects such as math, science, and engineering (Cano, 1993).
Garger and Guild (1984) indicated that field independents were better able to make specific concept distinctions with little overlap. Because field independents have well developed perceptions of discrete parts, they are able to take major tasks and break them down into smaller simpler tasks (Cano, 1993; Garger & Guild, 1984; Witkin, 1976; Witkin et al., 1977a, 1977b).

Field independents have an impersonal orientation, thus tend to generally be individualistic and insensitive to the needs or emotions of others (Cano, 1993; Garger & Guild, 1984; Witkin, 1976; Witkin et al., 1962; Witkin et al., 1977a). Field independents learn social material only as an intentional task and are interested in new concepts for their own sake (Garger & Guild, 1984; Witkin et al., 1962; Witkin et al., 1971). Preferring to work independently, field independents tend to become inattentive to the social environment when working and like independent projects (Cano, 1993; Reiff, 1992; Witkin et al., 1977a).

With regards to learning, field independents rarely seek physical contact with the instructor and do not want the instructor to offer any physical gestures, maintaining professional distance (Cano, 1993). Witkin et al. (1977a) indicated that, in the learning process, field independents preferred the hypothesis-testing approach to concept attainment. Field independents prefer to try learning tasks without the help of the instructor and are usually impatient
to begin the assigned tasks (Cano, 1993). Less instruction is required for field independents in problem-solving strategies, who may even perform better when allowed to develop their own strategies (Witkin et al., 1977a, 1977b).

Field independents are motivated intrinsically through competition, choice of activities, showing how the task is useful to them, and freedom to design their own structure (Cano, 1993; Garger & Guild, 1984; Reiff, 1992; Witkin, 1976; Witkin et al., 1962; Witkin et al., 1977a, 1977b). Garger and Guild (1984) indicated that field independents have self-defined goals and reinforcements, and were less affected by criticism.

Claxton and Ralston (1978) also suggested that there were differences between field dependents and field independents in speech patterns. Field dependents refer more to others than to themselves as they talk, while field independents use more personal pronouns and active verbs (e.g., "I did this" as opposed to "this happened to me") (Witkin, 1976; Claxton & Ralston, 1978).

Factors Related to Learning Styles

A review of literature highlighted several factors related to learning style. The most pronounce factors identified were intelligence, vocational and academic interest, and age.
Intelligence

Witkin (1976) emphasized that the differentiated character of learning styles was a less threatening concept than were cognitive abilities or intelligence. However, there was evidence that has shown a positive relationship between field independence and intelligence. Goodenough and Karp (1961) found some indication that measure of field dependence/independence was related to performance on the Wechsler IQ subtest of block design, picture completion, and object assembly. Goodenough and Karp (1961) interpreted the finding as providing evidence that the Wechsler IQ scales shared the skill of overcoming an embedding context with the measurement of field dependence/independence. In a later study, Karp (1963) found similar results.

In their test manual, Witkin et al. (1971) summarized the results of several studies on the relationship of EFT performance and intelligence. Witkin et al. (1971) presented evidence that the moderate correlations between the EFT and the Wechsler IQ scales were due to the relation between EFT performance and a Wechsler "analytical factor" (e.g., block design, object assembly, and picture completion).

Witkin (1976) indicated that on the three factor components of the Wechsler IQ test, the analytical factor was essentially identical with the field dependence/ independence dimension. Witkin (1976) suggested that therefore, it was not surprising to find measures of field dependence/independence
related to scores on the analytical factor, but minimally to scores on the other two factors. Goldstein and Blackman (1978) however, in reviewing 20 studies involving both children and undergraduates, found generally consistent indications that field dependence/independence was related to various measures of both verbal and performance intelligence. Nonetheless, Witkin (1976) argued that:

"In view of the important cognitive domains constituting an individual's intellect to which field dependence versus field independence does not relate, we clearly cannot equate the field dependence versus field independence dimension with general cognitive competence, or intelligence, even though that dimension must be considered an ingredient of intellect." (p. 43)

Supporting Witkin (1976), was Reiff (1992), who indicated that field dependent and field independent students had the same intellectual capacity, but field independent students had more cognitive flexibility than field dependent students.

With regards to academic achievement, Witkin et al. (1977b) found the field dependence/independence dimension to appear unrelated to overall academic achievement. The population consisted of an entire class of 1,548 students from a large municipal college. Witkin et al. (1977b) reported results indicating that the correlations between field dependence/independence and SAT-verbal scores were quite low
(male $r = .08$, female $r = .22$) and correlations between field dependence/independence and SAT-math scores were higher (male $r = .24$, female $r = .38$).

In addition, Witkin et al. (1977b) reported that field dependence/independence scores showed little relation to either high school GPA or GPA (high school: male $r = .01$, female $r = .03$; college: male $r = .10$, female $r = .05$). Furthermore, Witkin et al. (1977b) found that field dependence/independence was not related to amount of education, and reported that the mean field dependence/independence scores, using the GEFT, earned at college entry were 11.8 for students who left school before receiving their bachelor's degree, 11.6 for college graduates, and 11.6 for students who entered graduate school.

**Vocational and Academic Interest**

Further contrasting field dependent and field independent students suggests implications for career and vocational differentiation. Witkin et al. (1977a) believed that underlying the relationship between field dependence/independence and vocational/academic interests was the degree to which a particular area of education emphasized cognitive skills and personality attributes associated with either a field dependent or field independent tendency.

Students' scores on interest inventories and vocational preference inventories have been examined in relation to field dependence/independence in several studies cited in Witkin, (1976) and Witkin et al., (1977a, 1977b). A consistent
conclusion drawn was that field dependent students avoid domains in which analytical skills were called for, whereas field independent students favor such domains. Witkin (1976) and Witkin et al. (1977a) stated that field dependent persons favored people-oriented vocations requiring social skills. Vocational interests of field dependents include areas such as social sciences, rehabilitation counseling, elementary school teaching, social science teaching, business education teaching, persuasive activities (selling, advertising), the humanities, selling real estate, and administrative activities which involve dealing with people (e.g., personnel director, community recreation administrator, YMCA public administrator, school superintendent, and chamber of commerce director).

Field independent people, in contrast, favor more theoretical domains, such as engineering, mathematics, biological sciences, chemistry, architecture, and technical and mechanical activities (Witkin, 1976; Witkin et al., 1977a). In addition, Witkin et al. (1977a) indicated that some studies had field independent students showing interest in the teaching of mathematics, science, industrial arts, and vocational agriculture and showed interest in practical domains such as production manager, carpenter, forest service, farmer, and mechanic.

Congruent results were found when interests and preferences were examined when actual choice of majors in college were studied. DeRussy and Futch (1971) reported that
undergraduate science majors were significantly more field independent than liberal arts students. Similarly, Sofman, Hajosy, and Vojtisek (1976) found that science teachers were significantly more field independent than liberal arts teachers.

Witkin et al. (1977b) found that science majors were significantly more field independent than education majors, with students majoring in other areas falling in between. Although teacher preparation of students as a group, are relatively field dependent, there are variations among these students because their specific areas of specialization spread across a number of academic areas (Witkin et al., 1977b).

In a similar study, Frank (1986) supported the contention that field dependence/independence was related to choice of area of specialization among teacher education majors. The results indicated that teacher preparation of students in the specialized areas of natural sciences, mathematics, business, and physical education, tended to be more field independent than students specializing in the social sciences, humanities, family and child development, home economics, special education, and speech pathology (Frank, 1986).

Differences in the field dependence/independence dimension were also found within domains in vocational categories such as mathematics, science, architecture, engineering, social work, and teaching in various areas. For example, in psychology, field dependents tend to be interested
in clinical psychology whereas field independents tend to be interested in experimental psychology. In education, field dependents tend to be interested in becoming a social studies teacher whereas field independents were more interested in becoming a natural science teacher (Witkin et al., 1977a).

Related, it was found that field dependence/independence made a significant contribution to choice of educational-vocational specialty beyond that made by SAT-verbal and SAT-mathematics (Witkin et al., 1977b). Witkin et al. (1977b) further determined that a person's learning style did make an independent contribution in predicting final major choices at college graduation as well as graduate school fields of specialization.

Students whose preliminary major choices at college entry were compatible with their learning style, were likely to remain with those majors through college and into graduate school (Witkin et al., 1977b). Students who made incompatible preliminary choices tended to shift to more compatible domains in the course of their time in college (Witkin et al., 1977b).

Furthermore, Witkin (1976) found that shifts in majors tended to be more common among field dependents. Witkin (1976) noted that shifts out of mathematics and science were particularly common among field dependent students. A related finding revealed that among students who initially designated themselves as premedical, a science domain, the more field dependent students often abandoned the area (Witkin, 1976).
Witkin (1976) also indicated that field dependent students tended to have more difficulty in defining and articulating their career choices.

Age

Witkin et al. (1954) presented data on the relationship between age and field dependence/independence. Witkin et al. (1954) found that field independence tendencies increased sharply between the ages of 10 to 13 years and between the ages of 13 and 17 years. Moreover, Witkin et al. (1977a) indicated that once established, the field dependence/independence dimension was relatively stable over time. However, Crosson (1984) found that field independence declines in old age, so that older people of both genders were generally more field dependent than comparable samples of younger adults.

Gender Differences in Learning Style

Gender differences have been found in the field dependence/independence dimension by several researchers (Garger & Guild, 1984; Claxton & Ralston, 1978; Reiff, 1992; Saracho, 1989; Witkin, 1950; Witkin, 1976; Witkin et al., 1954; Witkin et al., 1962; Witkin et al., 1971; Witkin, 1976; Witkin, et al., 1977a, 1977b). The previously mentioned researchers have found that females tend to be more field dependent than males. Witkin et al. (1977a) indicated that while the differences between genders may be persistent, the
differences were small, beginning early in adolescence. Witkin and Berry (1975) suggested that evidence exists from cross-cultural studies that gender differences in field dependence/independence may be uncommon in mobile, hunting societies and prevalent in sedentary, agricultural societies—societies which are characteristically different in gender roles.

With regards to occupational preference and choice, Witkin (1976) indicated that females tended to prefer activities that involved dealing with people, whereas males tended to exhibit interests in areas requiring analytic skills. Witkin (1976) acknowledged that the marked gender differences in occupational preference and choice could hardly be assumed to be explained on the basis of field dependence/independence, rather gender roles within society and the time in life when occupational choices were made may be overriding factors in occupational preference and choice.

It has been argued that gender differences in field dependence/independence were artifacts of gender differences in spatial ability because both the Rod-and-Frame-Test (RFT) and the Embedded Figures Test (EFT) have a strong spatial component (Sherman, 1967). In a test of the hypothesis that gender differences in the RFT and EFT merely reflected differences in spatial ability, Hyde, Geiringer, and Yen (1975) administered a series of tests to a sample of college males and females.
The tests included the RFT, EFT, a spatial ability test, and an arithmetic test. All between-gender results were in the predicted direction with males performing better on the test of spatial ability, RFT, EFT, and arithmetic test. When Hyde, Geiringer, and Yen (1975) reanalyzed their data statistically controlling for differences in spatial ability, the results changed dramatically.

Gender differences in the RFT, EFT, and arithmetic test became nonsignificant. Reviewing Hyde, Geiringer, and Yen's (1975) study, Halpern (1986) concluded that "it would appear that the two spatial tests of field dependence and independence are not indicative of field dependence/independence, notwithstanding the claims of Witkin (1950), Witkin et al. (1954), and others, but merely reflect [gender] differences in visual-spatial ability" (p. 55). Halpern (1986) suggested that developmental data supported the notion that gender differences in field dependence/independence were really reflections of gender differences in spatial ability.

Summary of Learning Style

Witkin (1976) suggested that the most promising and exciting prospect for learning style approach rested in the field of education. Claxton and Ralston (1978) indicated that evidence on student learning styles had some very important and practical implications for persons concerned about effective teaching in colleges and universities.
Research (Avery, 1985; Jacobs, 1980; MacNeil, 1980; Witkin, 1973; Witkin, 1976; Witkin et al., 1962; Witkin et al., 1977a, 1977b) in education on learning styles has been demonstrated to be an important variable in several areas including students' academic development, choice of career or major, how students learn, and how students interact with teachers in the classroom. Goldstein and Blackman (1978) also indicated that the impact of a class, course, or curriculum, of a teacher, peer, or college subculture varied with the background, cognitive ability, and personality characteristics of the student.

Summary of Review of Literature

Arguments have been presented by researchers and educators on the importance of developing thinking skills in students. Thinking skills result from students' cognitive development. Educational research in cognitive development was largely based upon the hierarchical classification model of cognition developed by Bloom et al. (1956). Years of use of Bloom's taxonomy, in varied applications and settings, led to its general acceptance as a valid and reliable means of classification of levels of cognition (Miller, 1989). Stahl and Murphy (1981) labeled Bloom's taxonomy as a "classic system" which has dominated instructional design and evaluation for more than a quarter of a century.
From the literature presented in Chapter II, it appeared that students' cognitive development was associated with several variables. Such variables include teacher and student related factors, student personal characteristics, class and institutional size and environmental elements.

Thinking in students was also influenced by their learning style. Learning style could be described as an individual variation in modes of perceiving, remembering, and thinking, or as distinctive ways of apprehending, storing, transforming, and utilizing information (Kogan, 1971). The most widely studied dimension of learning style was field dependence/independence.

From the literature presented in Chapter II, it appeared that learning style was associated with numerous student characteristics. Learning style was identified to be a potential variable that influenced students' academic development and choice, vocational preference, and how students learn.

Thus, cognitive abilities and learning style of students were important factors in need of investigation at the college level. Bloom (1976) suggested that the purpose of education was not to produce individual differences in learning, but to reduce them.

A conceptual framework for the study was derived from the review of literature (See Conceptual Framework). The conceptual framework suggested the relationships between and
among the variables of interest (Cognitive Ability and Learning styles) and related factors (Personal Characteristics, Student-Related Factors, Teacher-Related Factors and Other Factors).
Conceptual Framework

Student-Related Factors
- Involvement
- Motivation
- Interest & value of course

Personal Characteristics
- Gender
- Age
- SES
- Ethnicity
- Educ./Occup. Aspiration
- Experience (background)
- Intelligence

Learning Styles

Cognitive Ability

Teacher-Related Factors
- Philosophical beliefs
- Preparation
- Cognitive expectation
- Tests & Assignments
- Instructional delivery

Other Factors
- Class size
- Institution size
- Environmental elements
CHAPTER III

METHODOLOGY

The purpose of the study was to describe the cognitive abilities and the learning style of students enrolled in the College of Agriculture at The Ohio State University. Furthermore, the study sought to relate cognitive abilities to selected student characteristics, including learning style. Chapter III will discuss the research design, population and sample, instrumentation, data collection, and the data analysis procedures utilized.

Research Design

The study was descriptive research. Ary, Jacobs, and Razavieh (1990) indicated that the aim of descriptive research was to describe "what exists" with respect to variables or conditions in a situation. Thus, the study was designed to obtain information about students concerning cognitive abilities, learning style, and personalological variables. Three instruments were utilized to gather the variety of data and information required to present a detailed account of each variable of interest and to accomplish the objectives of the study.
Population and Sample

The target population for the study was senior students (N=388) enrolled in the College of Agriculture at The Ohio State University and excluded the School of Natural Resources during Autumn Quarter, 1992. Only students meeting the following criteria were included in the study:

1) Having a rank four (4) at the end of the Autumn Quarter;
2) Enrolled on main campus;
3) Having full-time student status (12 or more credit hours) at the end of the Autumn Quarter;
4) Paid registration fees for Winter Quarter, 1993 by the 14th day of the Winter Quarter, 1993; and
5) Having full-time student status (12 or more credit hours) at the start of the Winter Quarter, 1993.

The names of the subjects in the population were obtained from the College of Agriculture Administration Office and served as the frame for the study.

For the study, the random sample was proportionally stratified by academic majors offered in college of Agriculture. A proportionally stratified sample was taken to ensure a balanced representation of each major. The College of Agriculture academic majors were: 1) Animal Science, 2) Agricultural Economics, 3) Horticulture, 4) Food Science, 5) Agronomy, 6) Agricultural Education, 7) Dairy Science, 8) Agricultural Communication, and 9) Agricultural Mechanics.
Referring to Kregcie and Morgan's (1970) table of sample sizes, the sample size required to be representative of the population (N=388) (within a five percent margin of error) was 196. The sample size (n=196) was proportionally stratified by major. Majors having extremely low counts (e.g., less than three (3)) such as Entomology, Rural Sociology, and Poultry Science were not included in the frame. The following proportional sample sizes were required for each major:

<table>
<thead>
<tr>
<th>Major</th>
<th>N</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Animal Science</td>
<td>96</td>
<td>49</td>
</tr>
<tr>
<td>2) Agricultural Economics</td>
<td>76</td>
<td>38</td>
</tr>
<tr>
<td>3) Horticulture</td>
<td>63</td>
<td>32</td>
</tr>
<tr>
<td>4) Agronomy</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>5) Food Science</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>6) Agricultural Education</td>
<td>27</td>
<td>14</td>
</tr>
<tr>
<td>7) Dairy Science</td>
<td>27</td>
<td>14</td>
</tr>
<tr>
<td>8) Agricultural Communication</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>9) Agricultural Mechanics</td>
<td>14</td>
<td>7</td>
</tr>
</tbody>
</table>

To ensure a random list of names proportional to the size of majors, students in the frame were assigned numbers ranging from one (1) to N for each major. Random numbers equal to the size of the sample (n) for each major were drawn using a computer generated list of random numbers, using a different list of random numbers for each major. Students whose assigned numbers were identified in the lists of random numbers were then identified, thus composing the proportional same size for the study (n=196).
Error in measurement was addressed by controlling sampling error, selection error, frame error, and by using valid and reliable instruments. Sampling error was controlled by ensuring an appropriate sample size and by using random selection techniques. Selection error was controlled by ensuring that the list of names was free from any duplicate names. Frame error was controlled by ensuring the frame contained an up-to-date list of names.

**Instrumentation**

Two standardized instruments were utilized to obtain data needed to address the objectives of the study. The two instruments were the Developing Cognitive Abilities Test (DCAT), Level L (Beggs & Mouw, 1989), and the Group Embedded Figure Test (Witkin, Oltman, Raskin, & Karp, 1971). In addition, a student personallogical data gathering instrument was utilized (Appendix B). A discussion of each of the three instruments follows.

**The Developing Cognitive Abilities Test, Level L**

The Developing Cognitive Abilities Test (DCAT), Level L was developed by Donald Beggs and John Mouw (1989). The DCAT was administered to all students in the study as a common measurement of cognitive abilities. Cognitive abilities tests attempt to assess the likelihood of one's capability to succeed at certain tasks in the future, if proper instruction
is received, and one is motivated to learn and demonstrate the skill needed to perform the task (Halpern, 1986).

The DCAT is group administered and measures characteristics and abilities that contribute to academic performance in students (American Testronics, 1990). The primary purpose of the DCAT is to identify differential abilities among students that are related to specifics topics or learning tasks taught (Beggs & Mouw, 1989) that can be modified through proper instructional techniques (Swartz, 1986). The intent of the DCAT is to provide an indication of the cognitive characteristics that can be altered in the school environment (Beggs & Mouw, 1989).

The DCAT was developed along a format structure that includes both a cognitive taxonomy (Bloom et al., 1956) and a content area taxonomy yielding scores on the two dimensions. The three levels of cognition in the DCAT are Basic Cognitive Abilities, Application Abilities, and Critical Thinking Abilities. The three levels of cognition (Basic, Application, and Critical Thinking) are consistent with the five lower cognitive levels of Bloom's taxonomy - Knowledge, Comprehension, Application, Analysis, and Synthesis (Table 3). The highest level of Bloom's taxonomy (1956), Evaluation, was deleted from the general intent of the DCAT.
Table 3

Comparison of Bloom's Taxonomy and the Developing Cognitive Abilities Test

<table>
<thead>
<tr>
<th>Bloom's Categories</th>
<th>DCAT Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Basic Cognitive Abilities</td>
</tr>
<tr>
<td>Comprehension</td>
<td></td>
</tr>
<tr>
<td>Application</td>
<td>Application Abilities</td>
</tr>
<tr>
<td>Analysis</td>
<td>Critical Thinking Abilities</td>
</tr>
<tr>
<td>Synthesis</td>
<td></td>
</tr>
</tbody>
</table>

The three content areas utilized in the test were verbal, quantitative, and spatial abilities. The verbal subtest measures the literal understanding and the appropriate use of words and phrases. The verbal subtest also measures the perception of interrelationships among series of statements by making inference from context or forming conclusions through propositional reasoning about given information (American Testronics, 1990).

The quantitative subtest measures the functional understanding of arithmetic operations, basic geometric concepts, and the ability to apply mathematical principles in the solution of story problems. The quantitative subtest also measures the ability to transform given information into new relationships required for the solution of problems (American Testronics, 1990).
The spatial subtest measures the recognition and retention of such characteristics of objects as size, shape, symmetry, and pattern. Also measured by the spatial subtest is the ability to estimate what would occur when one or more objects change in location or position. Furthermore, the spatial subtest measures the ability to mentally transform objects through imagination of the identification of the parts resulting from dividing an object (American Testronics, 1990).

The items in the three content areas (verbal, quantitative, and spatial) are classified into one of the three levels of cognition (Basic, Application, Critical Thinking). Eighty-one items constitute the DCAT and are arranged in verbal (27 items), quantitative (27 items), and spatial (27 items) order. Each 27-item section is timed and can be considered independent in analyzing the test results (Beggs, 1988). The three content areas (verbal, quantitative, and spatial) were utilized in the study.

The primary population for the DCAT are students enrolled in grades one through twelve (Levels C-L). Level L was used in the study and may be subject to "ceiling effect" as a potential threat to validity. The content areas having greatest potential for "ceiling effect" are verbal and quantitative (Personal communication with Beggs, September, 1992). Ceiling effect can be described as a situation where an instrument is unable to distinguish differences among
subjects' scores because the test is too simple (Personal communication with McCracken, October, 1992).

Several processes were involved in developing, standardizing, and validating the DCAT. The processes involved a team of authors, who were considered experts in their fields, and included: analyzing curricula and instructional practices; reviewing, field testing, and selecting items; norming and weighing; and scaling (Wick, 1990).

The reliability (Kuder-Richardson-20) of the DCAT was established by the developers for the three cognitive levels: Basic Cognitive Abilities, .81; Application Abilities, .76; Critical Thinking Abilities, .75; and overall, .90 (Wick, 1990). Using a similar group of college students, the reliability of the DCAT for the three cognitive levels was established by Miller (1989). Miller (1989) reported Kuder-Richardson 20 coefficients for the three levels of cognition. The resulting coefficients were .65 for Basic Cognitive Abilities, .59 for Application Abilities, and .72 for Critical Thinking Abilities.

The DCAT was administered to all students in the sample. The administration procedure followed those outlined in the Directions for Administration: Levels E-L • Form 3 (1989) source booklet. The total duration of the test for the verbal, quantitative, and spatial areas was no longer than the specified 60 minutes (Table 4). The DCAT was hand scored and
a percent-correct score calculated for each level of cognition (Basic, Application, and Critical Thinking) using the guidelines outlined by Wick, Beggs, and Mouw (1991).

Table 4
Number of Items and Time Limits for the DCAT, Level L

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Number of Items</th>
<th>Time Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal</td>
<td>27</td>
<td>15 min.</td>
</tr>
<tr>
<td>Quantitative</td>
<td>27</td>
<td>25 min.</td>
</tr>
<tr>
<td>Spatial</td>
<td>27</td>
<td>20 min.</td>
</tr>
<tr>
<td>TOTAL</td>
<td>81</td>
<td>60 min.</td>
</tr>
</tbody>
</table>

The Group Embedded Figures Test

The Group Embedded Figures Test (GEFT) was developed by Philip Oltman, Evelyn Raskin, and Herman Witkin (1971). The GEFT was administered to all students in the study as a common assessment of learning style.

The GEFT was developed to determine the preferred learning style of students as either field-dependent or independent. The GEFT is group administered and may be used over a broad age range (Witkin et al., 1971).

The GEFT contains three sections. The first section contains seven simple geometric figures and is used primarily for practice. The second and third sections, each contain
nine more difficult geometric figures. The two sections are scored by summing together the number of the 18 items on which the subjects correctly located the hidden figure within a more complex figure. The task on each trial is to locate a previously seen simple geometric figure within a larger complex figure which has been so organized as to obscure or embed the sought-after simple geometric figure. The ability to locate the embedded geometric figure is characteristic of field independence.

The GEFT requires 20 minutes to administer and is hand scored by using templates provided by the test distributor. Individuals scoring greater that the national mean (11.4) are considered to be leaning toward the field-independent learning style while subjects scoring less than the national mean are considered to be leaning toward the field-dependent learning style (Witkin et al., 1971).

The validity of the GEFT has been established by determining its relationship with its "parent" test: Embedded Figures Test (EFT), the Rod and Frame Test (RFT), and the Body Adjustment Test (BAT). The correlation coefficients between the GEFT and the EFT are -.82 for men (73 male undergraduates) and -.63 for females (68 female undergraduates) (Witkin et al., 1971, p. 29). The negative correlation coefficients are the result of differences in the scoring procedures between the two measures. The male-female correlation coefficients between the GEFT and the BAT are substantial, .71 and .55
respectively (Witkin et al., 1971, p. 29). Also reported were the correlation coefficients between the GEFT and the portable RFT: -.39 for males and -.34 for females (Witkin et al., 1971, p. 29).

Because the GEFT was a speed test, internal consistency was measured by treating each scored section (two & three) as split-halves. Witkin et al. (1971, p. 28) reported a corrected Spearman-Brown reliability coefficient of .82 on the GEFT for males and females combined. Carter and Loo (1980), using a sample of 266 undergraduates, reported an internal consistency coefficient (Cronbach's alpha) of .86. No stability coefficients were reported for the GEFT, however a test-retest reliability for the EFT was reported by Bauman (1951) as .89 over a three year interval (Witkin et al., 1971).

The GEFT was administered to all students in the sample. Procedures for administration of the GEFT followed those outlined in the Group Embedded Figures Tests Manual (Witkin et al., 1971).

**Student Personalogical Instrument**

A personalogical information instrument was developed by the researcher to gather data. The instrument was used to record personalogical data for all students in the study. Data gathered included gender, age, ethnicity, ACT composite score, cumulative GPA, and academic major (Appendix B). To
ensure accuracy, data were obtained from student records located in the Administration Office of the College of Agriculture.

Data Collection

The data collection period encompassed six weeks (Table 5). Students selected to participate in the study were mailed a letter (Appendix C) of invitation strongly encouraging the senior students to participate in the study. The letter was structured in accordance to Dillman (1978), explaining the importance of the study and instructions for participation. The letter was signed by L.H. Newcomb, the Associate Dean and Director of Academic Affairs for College of Agriculture at The Ohio State University.

The letter specified four dates with two data collection sessions on each date in which students were invited to attend any one of the eight sessions. Students were able to indicate their willingness to participate and to select and indicate on a self-addressed stamped post card (Appendix D) the date and time that best accommodated their schedule for attending the data collection session. Additionally, a local phone number was requested for follow-ups and rescheduling purposes.
Table 5

Schedule for Data Collection

<table>
<thead>
<tr>
<th>Week</th>
<th>Activity</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Invitation Letter</td>
<td>January 22, 1993</td>
</tr>
<tr>
<td>2</td>
<td>Postcard-response Wait Period</td>
<td>January 22-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>February 2, 1993</td>
</tr>
<tr>
<td>3</td>
<td>Phone Contacts</td>
<td>February 2-8, 1993</td>
</tr>
<tr>
<td>4</td>
<td>Confirmation Letter</td>
<td>February 9, 1993</td>
</tr>
<tr>
<td>5</td>
<td>Data Collection</td>
<td>February 16, 17, 18,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&amp; 22, 1993</td>
</tr>
<tr>
<td>6</td>
<td>Make-up Data Collection</td>
<td>February 24, 1993</td>
</tr>
</tbody>
</table>

To further encourage participation, all students were offered an incentive. All participants received a t-shirt with a screen print as a token of appreciation. In addition, participants were offered refreshments during all the data collection sessions.

Students who did not respond after 10 days of the initial mailing were contacted by phone by the researcher and encouraged to participate. One week prior to the first data collection date, willing participants were sent a confirmation letter (Appendix E) highlighting their chosen date, time, and location of the data collection session. The data collection
dates were carefully selected to avoid holidays, quarter midterms, final exams, and weekends. The data collection dates were in February, 1993. The data collection sessions were limited to the evening hours to avoid potential class conflicts. Specifically, the data collection dates were:

- Tuesday, February 16, 4:00 pm and 7:00 pm;
- Wednesday, February 17, 4:00 pm and 7:00 pm;
- Thursday, February 18, 4:00 pm and 7:00 pm; and
- Monday, February 22, 4:00 pm and 7:00 pm.

A make-up session, conducted on Wednesday, February 24, at 7:00 pm, was offered to participants unable to attend their scheduled session.

The data collection sessions required one hour and thirty minutes each. The one hour and thirty minute sessions allowed for the 60 minute DCAT administration, and 20 minutes for the GEFT administration. The remaining ten minutes were allowed for introductions, salutations, and for refreshments.

Participants were first given a short introduction to the data collection process and reassured of confidentiality of results. Following the introduction, participants were administered the GEFT instrument followed by the DCAT instrument.

The researcher administered the data collection instruments at all data collection sessions in accordance to the procedures specified in both the GEFT and DCAT manuals provided by the respective test distributors. The
participants were observed by the researcher and a college representative during the administration of the data collection instruments so that potential reactive arrangements could be identified. The researcher and a college representative were careful not to engage in any behaviors that could have a biased effect on the data. No instances of a disruptive nature occurred.

All data collection sessions were located in Room 105 of the Agricultural Administration Building. Arrangements were made in advance with the College of Agriculture Administration to reserve Room 105 for the specified dates. A total of 47% (92) of the sample participated in the eight scheduled and one make-up data collection sessions.

As a courtesy, two special one hour sessions (March 2, 1993; 4:00 and 6:30 pm) were offered to the participants. During the two special sessions, participants were provided with their scores and the researcher and a graduate associate explained and discussed the meaning and relevance of learning styles. A handout (Appendix F) was provided to the participants attending the special sessions.

Students who did not attend any of the data collection sessions were treated as non-respondents. A total of 53 percent (104) of the sample of students were non-respondents and were considered to be non-response error. Non-response error was controlled by sampling the non-respondents. The
process for addressing and controlling non-response error was recommended by Miller and Smith (1983).

The process of addressing non-response error involved sampling ten percent \((n=11)\) of the non-respondents. The non-respondents \((n=11)\) were randomly drawn and composed the sample of non-respondents. Students identified in the sample of non-respondents were mailed a letter (Appendix G) indicating the importance of their participation and strongly encouraged to participate. No scheduled sessions were imposed on the sample of non-respondents, rather students were asked to schedule a one hour and thirty minute session with the researcher to gather the required data using the GEFT and DCAT instruments. To ensure 100% participation, the researcher followed up the letter of invitation with a telephone call to the sample of non-respondents to either reschedule or remind students of the prearranged data collection session.

To determine if non-respondents were similar to respondents, non-respondents \((n=11)\) were statistically compared to respondents \((n=92)\) on selected variables. To determine if significant data differences were present, independent two tailed t-tests, were used to compare non-respondents to respondents on the variables of interest (learning style and cognitive abilities - Basic, Application, and Critical Thinking), cumulative GPA, and age at an alpha level of .05.
No significant differences ($p > .05$) were found between the sample of non-respondents and the sample of respondents on the variables of interest (learning style and cognitive abilities - Basic, Application, and Critical Thinking), cumulative GPA, and age (Table 6). Thus, the non-respondent data ($n=11$) were pooled with the respondent data ($n=92$) yielding a sample size of 103 and generalized to the sample/population (Miller & Smith, 1983).

Table 6

**Comparison of Non-Respondent to Respondents**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-respondents ($n=11$)</th>
<th>Respondents ($n=92$)</th>
<th>t-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Cognitive Abilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>19.73</td>
<td>3.88</td>
<td>19.87</td>
</tr>
<tr>
<td>Application</td>
<td>19.18</td>
<td>2.96</td>
<td>20.32</td>
</tr>
<tr>
<td>Critical Thinking</td>
<td>16.09</td>
<td>4.25</td>
<td>16.89</td>
</tr>
<tr>
<td>GEFT</td>
<td>13.09</td>
<td>3.89</td>
<td>12.33</td>
</tr>
<tr>
<td>Cumulative GPA</td>
<td>2.69</td>
<td>.66</td>
<td>2.75</td>
</tr>
<tr>
<td>Age</td>
<td>23.91</td>
<td>4.70</td>
<td>23.61</td>
</tr>
</tbody>
</table>

**Data Analysis**

Raw data were coded and entered into SPSS/PC+ (Statistical Package for the Social Science, Personal Computer version) Data Entry to employ statistical applications. Both descriptive and inferential statistics were used to analyze
the data. The data were analyzed utilizing the SPSS/PC+ program. The following presents specific procedures followed to arrive at the values entered into the data set.

The Developing Cognitive Abilities Test

The DCAT included items at the three levels of cognition (Basic Cognitive Abilities, Application Abilities, and Critical Thinking Abilities). Each student had the opportunity to respond to 81 items in the DCAT. Twenty-seven items were included in each of the three content areas, nine items in each of the three levels of cognition (Table 7).

Table 7

Items Structure for the Developing Cognitive Abilities Test

<table>
<thead>
<tr>
<th>Levels of Cognition</th>
<th>Verbal</th>
<th>Quantitative</th>
<th>Spatial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Cognitive Abilities</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Application Abilities</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Critical Thinking Abilities</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

The verbal, quantitative, and spatial sections of the test were used in the study. The total score from each of the three levels of cognition (Basic Cognitive Abilities,
Application Abilities, Critical Thinking Abilities) ranged from 0 to 27 and were hand scored by the researcher. The raw scores for each of the three levels of cognition were calculated and recorded for each student.

The Group Embedded Figures Test

Each student had the opportunity to respond to 18 items in the GEFT. Possible scores on the GEFT ranged from 0 to 18 and were hand scored by the researcher. The number of items correct was determined and recorded for each student.

Research Objectives: Analyses

The following is a description of the statistical analyses used to accomplish each of the research objectives of the study.

1. Describe senior students of the College of Agriculture at The Ohio State University on the following personal and logical variables: age, gender, ACT composite score, cumulative GPA, choice of academic major, and ethnic background.

Frequency counts, percentages, means, standard deviations, and range were used to describe students' age, ACT composite score, and cumulative GPA. Frequency counts, and percentages were used to describe students regarding gender, choice of academic major, and ethnic background.

2. Determine the cognitive abilities (Basic, Application, and Critical Thinking) of senior students enrolled in the
College of Agriculture at The Ohio State University as measured by the Developing Cognitive Abilities Test (DCAT), Level L.

Percentages, means, standard deviations, and ranges were used to describe students' cognitive abilities on Basic Cognitive Abilities, Application Abilities, and Critical Thinking Abilities.

3. Determine the learning style of senior students enrolled in the College of Agriculture at The Ohio State University as measured by the Group Embedded Figures Test (GEFT).

Frequency counts, percentages, and a range were used to describe students' learning style.

4. Describe the relationship between cognitive abilities (Basic, Application, and Critical Thinking) utilizing the DCAT and selected variables (age, gender, cumulative GPA, ACT composite score, academic major, ethnic background) of senior students enrolled in the College of Agriculture at The Ohio State University.

Pearson product-moment correlation coefficients were used to describe the relationships between students' cognitive abilities (Basic Cognitive Abilities, Application Abilities, Critical Thinking Abilities) and their age, college cumulative GPA, and ACT composite score. Point-biserial correlation coefficients were used to describe the relationships between students' cognitive abilities (Basic Cognitive Abilities,
Application Abilities, Critical Thinking Abilities) and their gender. Dummy coding procedures were utilized for nominal/categorical variables. Multiple regression techniques were utilized to describe the relationships between students' cognitive abilities (Basic Cognitive Abilities, Application Abilities, Critical Thinking Abilities) and their academic major and ethnic background.

5. Describe the relationship between learning style utilizing the GEFT and selected variables (age, gender, cumulative GPA, ACT composite score, academic major, ethnic background) of senior students enrolled in the College of Agriculture at The Ohio State University.

Pearson product-moment correlation coefficients were used to describe the relationship between students' learning style and their age, college cumulative GPA, and ACT composite score. Point-biserial correlations were use to describe the relationship between students' learning style and their gender. Dummy coding procedures were utilized for nominal/categorical variables. Multiple regression techniques were utilized to describe the relationship between students' learning style and their academic major and ethnic background.

6. Describe the relationships between cognitive abilities (Basic, Application, and Critical Thinking) utilizing the DCAT and learning style utilizing the GEFT of senior students enrolled in the College of Agriculture at The Ohio State University.
Pearson product-moment correlation coefficients were used to describe the relationships between students' cognitive abilities (Basic Cognitive Abilities, Application Abilities, Critical Thinking Abilities) and learning style.

The alpha level of .05 was set \textit{a priori}. Davis' (1971) conventions were used to interpret the magnitude of all relationships reported in the study. Davis' (1971) conventions were as follows:

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>.70 or greater</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>
CHAPTER IV
FINDINGS

The purpose of the study was to describe the cognitive abilities and the learning style of students enrolled in the College of Agriculture at The Ohio State University. Furthermore, the study sought to relate cognitive abilities to selected student characteristics, including learning style.

Chapter IV contains the findings of the study. The findings were presented in the order of the objectives of the study. The rubrics for the ensuing chapter includes: 1) students' characteristics; 2) students' cognitive abilities; 3) students' learning style; 4) correlates of students' cognitive abilities; 5) correlates of students' learning style; and the relationship between cognitive abilities and learning style of students.

Students' Characteristics

Personalological data were gather on 103 senior students enrolled in the College of Agriculture, The Ohio State University during Autumn Quarter, 1992. Personalological data included age, gender, academic major, ethnicity, cumulative
GPA, and ACT composite score. The ensuing results are a description of the personalogical variables.

**Age**

The age of senior students ranged from 22 to 41 years of age. The mean age for the senior students was 23.7 years with a standard deviation of 4.14. The mode age of senior students was 22 years of age (Table 8).

**Gender**

Of the 103 senior students who participated in the study, 57.3 percent (59) were male and 42.7 percent (44) were female (Table 9).

**Table 8**

**Age of Students**  (n=103)

<table>
<thead>
<tr>
<th>Age</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cum. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 - 22</td>
<td>57</td>
<td>55.3</td>
<td>55.3</td>
</tr>
<tr>
<td>23 - 25</td>
<td>32</td>
<td>31.1</td>
<td>86.3</td>
</tr>
<tr>
<td>26 - 29</td>
<td>6</td>
<td>5.7</td>
<td>92.1</td>
</tr>
<tr>
<td>30 - 32</td>
<td>1</td>
<td>1.0</td>
<td>93.1</td>
</tr>
<tr>
<td>33 - 35</td>
<td>1</td>
<td>1.0</td>
<td>94.1</td>
</tr>
<tr>
<td>36 - 39</td>
<td>5</td>
<td>4.9</td>
<td>99.9</td>
</tr>
<tr>
<td>40 - 42</td>
<td>1</td>
<td>1.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Mean = 23.7
Std. Dev. = 4.14
Mode = 22
Range = 20 - 41
Table 9

Gender of Students (n=103)

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cum. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>59</td>
<td>57.3</td>
<td>57.3</td>
</tr>
<tr>
<td>Female</td>
<td>44</td>
<td>42.7</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Academic Major

College records were utilized to identify students' academic major. Of the 103 senior students, it found that the academic major with the largest proportion (26.2%) of students was Animal Science (n=27) (Table 10). The academic majors that followed were: Agricultural Economics (20.4%; n=21); Horticulture (15.5%; n=16); Agricultural Education (10.7%; n=11); Food Science (7.8%; n=8); Dairy Science (6.8%; n=7); Agronomy (6.8%; n=7); Agricultural Communication (3.4%; n=4); and Agricultural Mechanics (1.9%; n=2). Of the nine academic majors, over 50 percent of the senior students were majoring in Animal Science, Agricultural Economics, and Horticulture. In addition, it was found that sample student proportions by academic major appeared to be similar when compared to actual (population) student proportions by academic major (Table 10).
Table 10

College Academic Major of Students (n=103)

<table>
<thead>
<tr>
<th>Major</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cum. %</th>
<th>N %a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Science</td>
<td>27</td>
<td>26.2</td>
<td>26.2</td>
<td>24.7</td>
</tr>
<tr>
<td>Agricultural Economics</td>
<td>21</td>
<td>20.4</td>
<td>46.6</td>
<td>19.6</td>
</tr>
<tr>
<td>Horticulture</td>
<td>16</td>
<td>15.5</td>
<td>62.1</td>
<td>16.2</td>
</tr>
<tr>
<td>Agricultural Education</td>
<td>11</td>
<td>10.7</td>
<td>72.8</td>
<td>10.3</td>
</tr>
<tr>
<td>Food Science</td>
<td>8</td>
<td>7.8</td>
<td>80.6</td>
<td>7.7</td>
</tr>
<tr>
<td>Dairy Science</td>
<td>7</td>
<td>6.8</td>
<td>87.6</td>
<td>7.0</td>
</tr>
<tr>
<td>Agronomy</td>
<td>7</td>
<td>6.8</td>
<td>94.2</td>
<td>7.0</td>
</tr>
<tr>
<td>Agricultural Communication</td>
<td>4</td>
<td>3.9</td>
<td>98.1</td>
<td>3.9</td>
</tr>
<tr>
<td>Agricultural Mechanics</td>
<td>2</td>
<td>1.9</td>
<td>100.0</td>
<td>3.6</td>
</tr>
</tbody>
</table>

a: Actual population proportions by academic major

Ethnicity

Three ethnic groups were identified from the 103 senior students. The three ethnic groups were: White, African-American, and Hispanic. It was found that an overwhelming proportion (94.2%) of the senior students were White (n=97). African-Americans made-up 4.8 percent (n=5) of the senior students and only one senior student (1.0%) was Hispanic (Table 11). As a result of the under-representation of
African-American and Hispanic groups, ethnicity as a variable of interest was eliminated from further analyses.

Table 11

**Ethnicity of Students (n=103)**

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cum. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>97</td>
<td>94.2</td>
<td>94.2</td>
</tr>
<tr>
<td>African-American</td>
<td>5</td>
<td>4.8</td>
<td>99.0</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1</td>
<td>1.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**Cumulative GPA**

The College of Agriculture Office served as the source for gathering data on the cumulative GPA of the 103 senior students. The senior students ranged in cumulative GPA from 1.84 to 3.98. The mean cumulative GPA for senior students was 2.75 with a standard deviation of .57 (Table 12).
Table 12

Cumulative Grade Point Average of Students (n=103)

<table>
<thead>
<tr>
<th>GPA</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cum. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.51 - 2.00</td>
<td>12</td>
<td>11.6</td>
<td>11.6</td>
</tr>
<tr>
<td>2.01 - 2.50</td>
<td>28</td>
<td>27.2</td>
<td>38.8</td>
</tr>
<tr>
<td>2.51 - 3.00</td>
<td>31</td>
<td>30.1</td>
<td>68.8</td>
</tr>
<tr>
<td>3.01 - 3.50</td>
<td>18</td>
<td>17.5</td>
<td>86.9</td>
</tr>
<tr>
<td>3.51 - 4.00</td>
<td>14</td>
<td>13.6</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Mean = 2.75
Std. Dev. = .57
Range = 1.84 - 3.98

ACT Composite Score

The College of Agriculture Office served as the source for gathering data on the ACT composite score for the senior students. Of the 103 senior students, an ACT composite score was available for 84 students (82.0%). For the 84 students, ACT composite score ranged from 9 to 31. The means ACT composite score for the 84 senior students was 21.26 with a standard deviation of 4.22. The mode ACT composite score was 24 (Table 13).
Table 13

ACT Composite Score of Students (n=103)

<table>
<thead>
<tr>
<th>ACT</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cum. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 - 10</td>
<td>1</td>
<td>1.2</td>
<td>1.0</td>
</tr>
<tr>
<td>11 - 15</td>
<td>7</td>
<td>6.8</td>
<td>7.8</td>
</tr>
<tr>
<td>16 - 20</td>
<td>28</td>
<td>27.2</td>
<td>35.0</td>
</tr>
<tr>
<td>21 - 25</td>
<td>35</td>
<td>34.0</td>
<td>69.0</td>
</tr>
<tr>
<td>26 - 30</td>
<td>12</td>
<td>11.6</td>
<td>80.6</td>
</tr>
<tr>
<td>31 - 35</td>
<td>1</td>
<td>1.0</td>
<td>89.6</td>
</tr>
<tr>
<td>Missing</td>
<td>19</td>
<td>18.4</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Mean = 21.26
Std. Dev. = 4.22
Mode = 24
Range = 9 - 31

Students' Cognitive Abilities

Students' cognitive abilities scores were gathered utilizing the Developing Cognitive Abilities Test - Level L (DCAT) (Beggs & Mouw, 1989). The DCAT provided scores on the 103 senior students on three levels of cognition. The three levels of cognition were: Basic Cognitive Abilities, Application Abilities, and Critical Thinking Abilities. For each of the three levels of cognition (Basic Cognitive Abilities, Application Abilities, Critical Thinking Abilities), a maximum raw score of 27 was possible.
The raw scores ranged from 8 to 27 on the Basic Cognitive Abilities items of the DCAT for senior students. The mean raw score for senior students on the Basic Cognitive Abilities items was 19.9 with a standard deviation of 3.63 (Table 14).

The senior students ranged in raw score for the Application Abilities items from 12 to 26. The mean raw score for the Application Abilities items was 20.2 with a standard deviation of 3.19 (Table 14).

The range of raw scores for senior students on the Critical Thinking Abilities items was 6 to 26. The mean raw score for the Critical Thinking Abilities items was 16.2 with a standard deviation of 3.96 (Table 14).

Table 14

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Cognitive Abilities</td>
<td>19.9</td>
<td>3.63</td>
<td>8 - 27</td>
</tr>
<tr>
<td>Application Abilities</td>
<td>20.2</td>
<td>3.19</td>
<td>12 - 26</td>
</tr>
<tr>
<td>Critical Thinking Abilities</td>
<td>16.8</td>
<td>3.96</td>
<td>6 - 26</td>
</tr>
</tbody>
</table>

Note. Based on Raw Scores (total possible score = 27)
Cognitive Abilities by Gender

A gender analysis (Tables 15 & 16) indicated that male senior students scored a raw mean of 20.2 on Basic Cognitive Abilities items with a standard deviation of 3.43. The raw scores for males on Basic Cognitive Abilities items ranged from 10 to 27 (Table 15). The mean raw score for males on Application Abilities items was 20.9 with a standard deviation of 2.91. The range of raw scores on Application Abilities items for males was 14 to 26 (Table 15). In addition, the mean raw score for males on Critical Thinking Abilities items was 16.7 with a standard deviation 3.78. The scores on Critical Thinking Abilities items ranged from 6 to 25 for males (Table 15).

Table 15

Performance on the Developing Cognitive Abilities Test by Gender - Male (n=59)

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Cognitive Abilities</td>
<td>20.2</td>
<td>3.43</td>
<td>10 - 27</td>
</tr>
<tr>
<td>Application Abilities</td>
<td>20.9</td>
<td>2.91</td>
<td>14 - 26</td>
</tr>
<tr>
<td>Critical Thinking Abilities</td>
<td>16.7</td>
<td>3.78</td>
<td>6 - 25</td>
</tr>
</tbody>
</table>

Note. Based on Raw Scores (total possible score = 27)
Female senior students scored a raw mean of 19.4 on Basic Cognitive Abilities items with a standard deviation of 3.88. The raw scores for females on Basic Cognitive Abilities items ranged from 8 to 26 (Table 16). The mean raw score for females on Application Abilities items was 19.3 with a standard deviation of 3.34. The range of raw scores on Application Abilities items for females was 12 to 25 (Table 16). In addition, the mean raw score for females on Critical Thinking Abilities items was 16.9 with a standard deviation 4.23. The scores on Critical Thinking Abilities items ranged from 6 to 26 for females (Table 16).

Table 16

<table>
<thead>
<tr>
<th>Level of Cognition</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Cognitive Abilities</td>
<td>19.4</td>
<td>3.88</td>
<td>8 - 27</td>
</tr>
<tr>
<td>Application Abilities</td>
<td>19.3</td>
<td>3.34</td>
<td>12 - 25</td>
</tr>
<tr>
<td>Critical Thinking Abilities</td>
<td>16.9</td>
<td>4.23</td>
<td>6 - 26</td>
</tr>
</tbody>
</table>

Note. Based on Raw Scores (total possible score = 27)

Cognitive Abilities by Academic Major

A raw mean score, standard deviation, and range was calculated for each academic major on the three levels of
cognition (Basic Cognitive Abilities, Application Abilities, Critical Thinking Abilities) (Table 17).

**Basic Cognitive Abilities**

The raw scores for the Basic Cognitive Abilities items of the DCAT are provided in Table 17 for each of the nine (9) academic majors (Animal Science, Agricultural Economics, Horticulture, Agricultural Education, Food Science, Dairy Science, Agronomy, Agricultural Education, Agricultural Mechanics). The raw means for the academic majors on the Basic Cognitive Abilities ranged from 19.1 to 22.3.

**Animal Science**

Of the 27 senior students majoring in Animal Science, the raw Basic Cognitive Abilities scores ranged from 14 to 25. The mean raw Basic Cognitive Abilities score was 20.4 with a standard deviation of 2.83 (Table 17).

**Agricultural Economics**

Of the 21 senior students majoring in Agricultural Economics, the raw Basic Cognitive Abilities scores ranged from 13 to 25. The mean raw Basic Cognitive Abilities score was 19.1 with a standard deviation of 3.74 (Table 17).

**Horticulture**

Of the 16 senior students majoring in Horticulture, the raw Basic Cognitive Abilities scores ranged from 12 to 24. The mean raw Basic Cognitive Abilities score was 18.3 with a standard deviation of 3.72 (Table 17).
Table 17

Performance on the Developing Cognitive Abilities Test - Basic Cognitive Abilities (n=103)

<table>
<thead>
<tr>
<th>Major</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Science</td>
<td>27</td>
<td>20.4</td>
<td>2.83</td>
<td>14 - 25</td>
</tr>
<tr>
<td>Agricultural Education</td>
<td>11</td>
<td>20.6</td>
<td>1.69</td>
<td>17 - 23</td>
</tr>
<tr>
<td>Food Science</td>
<td>8</td>
<td>20.4</td>
<td>5.18</td>
<td>10 - 26</td>
</tr>
<tr>
<td>Dairy Science</td>
<td>7</td>
<td>22.3</td>
<td>2.81</td>
<td>20 - 27</td>
</tr>
<tr>
<td>Agronomy</td>
<td>7</td>
<td>19.4</td>
<td>3.74</td>
<td>16 - 26</td>
</tr>
<tr>
<td>Agricultural Education</td>
<td>4</td>
<td>19.3</td>
<td>7.80</td>
<td>8 - 26</td>
</tr>
<tr>
<td>Mechanics</td>
<td>2</td>
<td>21.5</td>
<td>.71</td>
<td>21 - 22</td>
</tr>
<tr>
<td>OVERALL</td>
<td>103</td>
<td>19.9</td>
<td>3.63</td>
<td>8 - 27</td>
</tr>
</tbody>
</table>

Note. Based on Raw Scores (total possible score = 27)

Agricultural Education

Of the 11 senior students majoring in Agricultural Education, the raw Basic Cognitive Abilities scores ranged
from 17 to 23. The mean raw Basic Cognitive Abilities score was 20.6 with a standard deviation of 1.92 (Table 17).

**Food Science**

Of the 8 senior students majoring in Food Science, the raw Basic Cognitive Abilities scores ranged from 10 to 26. The mean raw Basic Cognitive Abilities score was 20.4 with a standard deviation of 5.18 (Table 17).

**Dairy Science**

Of the 7 senior students majoring in Dairy Science, the raw Basic Cognitive Abilities scores ranged from 20 to a maximum score of 27. The mean raw Basic Cognitive Abilities score was 22.3 with a standard deviation of 2.81 (Table 17).

**Agronomy**

Of the 7 senior students majoring in Agronomy, the raw Basic Cognitive Abilities scores ranged from 16 to 26. The mean raw Basic Cognitive Abilities score was 19.4 with a standard deviation of 3.74 (Table 17).

**Agricultural Communication**

Of the 4 senior students majoring in Agricultural Communication, the raw Basic Cognitive Abilities scores ranged from 8 to 26. The mean raw Basic Cognitive Abilities score was 19.3 with a standard deviation of 7.80 (Table 17).

**Agricultural Mechanics**

Of the 2 senior students majoring in Agricultural Mechanics, the raw Basic Cognitive Abilities scores ranged
from 21 to 22. The mean raw Basic Cognitive Abilities score was 21.5 with a standard deviation of .71 (Table 17).

Application Abilities

The raw scores for the Application Abilities items of the DCAT are provided in Table 18 for each of the nine (9) academic majors (Animal Science, Agricultural Economics, Horticulture, Agricultural Education, Food Science, Dairy Science, Agronomy, Agricultural Education, Agricultural Mechanics). The raw means for the academic majors on the Application Abilities ranged from 17.5 to 22.6.

Animal Science

Of the 27 senior students majoring in Animal Science, the raw Application Abilities scores ranged from 15 to 25. The mean raw Application Abilities score was 19.7 with a standard deviation of 2.79 (Table 18).

Agricultural Economics

Of the 21 senior students majoring in Agricultural Economics, the raw Application Abilities scores ranged from 12 to 26. The mean raw Application Abilities score was 19.6 with a standard deviation of 4.06 (Table 18).

Horticulture

Of the 16 senior students majoring in Horticulture, the raw Application Abilities scores ranged from 17 to 25. The mean raw Application Abilities score was 19.9 with a standard deviation of 2.54 (Table 18).
Table 18

Performance on the Developing Cognitive Abilities Test - Application Abilities (n=103)

<table>
<thead>
<tr>
<th>Major</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Science</td>
<td>27</td>
<td>19.7</td>
<td>2.79</td>
<td>15 - 25</td>
</tr>
<tr>
<td>Agricultural Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td>21</td>
<td>19.6</td>
<td>4.06</td>
<td>12 - 26</td>
</tr>
<tr>
<td>Horticulture</td>
<td>16</td>
<td>19.9</td>
<td>2.54</td>
<td>17 - 25</td>
</tr>
<tr>
<td>Agricultural Education</td>
<td>11</td>
<td>22.6</td>
<td>1.92</td>
<td>19 - 25</td>
</tr>
<tr>
<td>Food Science</td>
<td>8</td>
<td>20.8</td>
<td>4.13</td>
<td>14 - 25</td>
</tr>
<tr>
<td>Dairy Science</td>
<td>7</td>
<td>21.3</td>
<td>2.29</td>
<td>17 - 24</td>
</tr>
<tr>
<td>Agronomy</td>
<td>7</td>
<td>20.6</td>
<td>2.64</td>
<td>16 - 23</td>
</tr>
<tr>
<td>Agricultural Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>4</td>
<td>17.5</td>
<td>4.12</td>
<td>13 - 21</td>
</tr>
<tr>
<td>Agricultural Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanics</td>
<td>2</td>
<td>21.0</td>
<td>2.83</td>
<td>19 - 23</td>
</tr>
<tr>
<td>OVERALL</td>
<td>103</td>
<td>20.2</td>
<td>3.19</td>
<td>12 - 26</td>
</tr>
</tbody>
</table>

Note. Based on Raw Scores (total possible score = 27)

Agricultural Education

Of the 11 senior students majoring in Agricultural Education, the raw Application Abilities scores ranged from 19
to 25. The mean raw Application Abilities score was 22.6 with a standard deviation of 1.92 (Table 18).

**Food Science**

Of the 8 senior students majoring in Food Science, the raw Application Abilities scores ranged from 14 to 25. The mean raw Application Abilities score was 20.8 with a standard deviation of 4.13 (Table 18).

**Dairy Science**

Of the 7 senior students majoring in Dairy Science, the raw Application Abilities scores ranged from 17 to 24. The mean raw Application Abilities score was 21.3 with a standard deviation of 2.29 (Table 18).

**Agronomy**

Of the 7 senior students majoring in Agronomy, the raw Application Abilities scores ranged from 16 to 23. The mean raw Application Abilities score was 20.6 with a standard deviation of 2.64 (Table 18).

**Agricultural Communication**

Of the 4 senior students majoring in Agricultural Communication, the raw Application Abilities scores ranged from 13 to 21. The mean raw Application Abilities score was 17.5 with a standard deviation of 4.12 (Table 18).

**Agricultural Mechanics**

Of the 2 senior students majoring in Agricultural Mechanics, the raw Application Abilities scores ranged from 19
to 23. The mean raw Application Abilities score was 21.0 with a standard deviation of 2.83 (Table 18).

Critical Thinking Abilities

The raw scores for the Critical Thinking Abilities items of the DCAT are provided in Table 19 for each of the nine (9) academic majors (Animal Science, Agricultural Economics, Horticulture, Agricultural Education, Food Science, Dairy Science, Agronomy, Agricultural Education, Agricultural Mechanics). The raw means for the academic majors on the Critical Thinking Abilities ranged from 15.1 to 18.5.

Animal Science

Of the 27 senior students majoring in Animal Science, the raw Critical Thinking Abilities scores ranged from 6 to 25. The mean raw Critical Thinking Abilities score was 17.4 with a standard deviation of 3.91 (Table 19).

Agricultural Economics

Of the 21 senior students majoring in Agricultural Economics, the raw Critical Thinking Abilities scores ranged from 6 to 23. The mean raw Critical Thinking Abilities score was 16.6 with a standard deviation of 4.07 (Table 19).

Horticulture

Of the 16 senior students majoring in Horticulture, the raw Critical Thinking Abilities scores ranged from 1 to 26. The mean raw Critical Thinking Abilities score was 16.1 with a standard deviation of 3.53 (Table 19).
Table 19

Performance on the Developing Cognitive Abilities Test - Critical Thinking Abilities (n=103)

<table>
<thead>
<tr>
<th>Major</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Science</td>
<td>27</td>
<td>17.4</td>
<td>3.91</td>
<td>6 - 25</td>
</tr>
<tr>
<td>Agricultural Education</td>
<td>11</td>
<td>18.1</td>
<td>2.94</td>
<td>13 - 22</td>
</tr>
<tr>
<td>Agriculture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td>21</td>
<td>16.6</td>
<td>4.07</td>
<td>6 - 23</td>
</tr>
<tr>
<td>Horticulture</td>
<td>16</td>
<td>16.1</td>
<td>3.53</td>
<td>12 - 26</td>
</tr>
<tr>
<td>Food Science</td>
<td>8</td>
<td>16.4</td>
<td>6.97</td>
<td>6 - 25</td>
</tr>
<tr>
<td>Dairy Science</td>
<td>7</td>
<td>16.4</td>
<td>3.36</td>
<td>12 - 21</td>
</tr>
<tr>
<td>Agronomy</td>
<td>7</td>
<td>15.1</td>
<td>3.34</td>
<td>9 - 19</td>
</tr>
<tr>
<td>Agricultural Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>4</td>
<td>16.3</td>
<td>4.27</td>
<td>13 - 22</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanics</td>
<td>2</td>
<td>18.5</td>
<td>.71</td>
<td>18 - 19</td>
</tr>
<tr>
<td>OVERALL</td>
<td>103</td>
<td>16.8</td>
<td>3.96</td>
<td>6 - 26</td>
</tr>
</tbody>
</table>

Note. Based on Raw Scores (total possible score = 27)

Agricultural Education

Of the 11 senior students majoring in Agricultural Education, the raw Critical Thinking Abilities scores ranged
from 13 to 22. The mean raw Critical Thinking Abilities score was 18.3 with a standard deviation of 2.94 (Table 19).

**Food Science**

Of the 8 senior students majoring in Food Science, the raw Critical Thinking Abilities scores ranged from 6 to 25. The mean raw Critical Thinking Abilities score was 16.4 with a standard deviation of 6.97 (Table 19).

**Dairy Science**

Of the 7 senior students majoring in Dairy Science, the raw Critical Thinking Abilities scores ranged from 12 to 21. The mean raw Critical Thinking Abilities score was 16.4 with a standard deviation of 3.36 (Table 19).

**Agronomy**

Of the 7 senior students majoring in Agronomy, the raw Critical Thinking Abilities scores ranged from 9 to 19. The mean raw Critical Thinking Abilities score was 15.1 with a standard deviation of 3.34 (Table 19).

**Agricultural Communication**

Of the 4 senior students majoring in Agricultural Communication, the raw Critical Thinking Abilities scores ranged from 13 to 22. The mean raw Critical Thinking Abilities score was 16.3 with a standard deviation of 4.27 (Table 19).

**Agricultural Mechanics**

Of the 2 senior students majoring in Agricultural Mechanics, the raw Critical Thinking Abilities scores ranged
from 18 - 19. The mean raw Critical Thinking Abilities score was 18.5 with a standard deviation of .71 (Table 19).

**Students' Learning Style**

The Group Embedded Figures Test (GEFT) (Oltman, Raskin, & Witkin, 1971) was used to gather data on the preferred learning styles of senior students enrolled in the College of Agriculture, The Ohio State University during Autumn Quarter, 1992. The preferred learning style of senior students were dichotomized as either field dependent or field independent. Senior students whose raw GEFT score was greater than the national mean (11.4) (Witkin, Oltman, Raskin, & Karp, 1971) were considered to be leaning toward a field independent learning style. Senior students whose raw GEFT score was less than the national mean were considered to be leaning toward a field dependent learning style (Witkin et al., 1971). The total possible raw score on the GEFT is 18.

An analysis of the GEFT scores indicated that 38.8 percent (n=40) of the senior students leaned toward a field dependent learning style (Table 20). Conversely, 61.2 percent (n=64) of the senior students leaned toward the field independent learning style. The mean raw GEFT score for senior students was 12.4 with a standard deviation of 4.27. The raw GEFT scores for senior students ranged from 1 to the maximum possible score of 18 (Table 21).
Table 20

Preferred Learning Style by Gender (n=103)

<table>
<thead>
<tr>
<th>Gender</th>
<th>Field-Dependence</th>
<th>GEFT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Freq.</td>
<td>%</td>
</tr>
<tr>
<td>Male</td>
<td>17</td>
<td>28.8</td>
</tr>
<tr>
<td>Females</td>
<td>23</td>
<td>52.3</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>38.8</td>
</tr>
</tbody>
</table>

Learning Style by Gender

A gender analysis (Table 20) indicated that 28.8 percent (n=17) of the males leaned toward the field dependent learning style while a majority (71.2%; n=42) of the males leaned toward a field independent learning style. Approximately 50 percent (n=23) of the females leaned toward the field dependent learning and approximately 50 percent (n=21) toward the field independent learning style.

The raw GEFT scores ranged from 1 to 18 for males and 2 to 18 for females. The mean raw GEFT score for males was 13.4 with a standard deviation of 3.75. The average raw GEFT score for females was 11.1 with a standard deviation of 4.62 (Table 21).
Table 21
Mean Preferred Learning Style Score by Gender (n=103)

<table>
<thead>
<tr>
<th>Gender</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>59</td>
<td>13.4</td>
<td>3.75</td>
<td>1 - 18</td>
</tr>
<tr>
<td>Female</td>
<td>44</td>
<td>11.1</td>
<td>4.62</td>
<td>2 - 18</td>
</tr>
<tr>
<td>Overall</td>
<td>103</td>
<td>12.4</td>
<td>4.27</td>
<td>1 - 18</td>
</tr>
</tbody>
</table>

Note. Based on Raw Scores (total possible score = 18)

Learning Style by Academic Major

A raw GEFT mean score, standard deviation, and range was calculated for each of the nine (9) academic majors (Animal Science, Agricultural Economics, Horticulture, Agricultural Education, Food Science, Dairy Science, Agronomy, Agricultural Education, Agricultural Mechanics). The raw mean scores for the academic majors on the GEFT ranged from 8.5 to 15.6 (Table 23).

Animal Science

Of the 27 senior students majoring in Animal Science, 29.4 percent (n=8) leaned toward the field dependent learning style and 70.4 percent (n=19) leaned toward the field independent learning style (Table 22). The raw GEFT scores ranged from 2 to 18. The mean raw GEFT score was 13.1 with a standard deviation of 3.99 (Table 23).
Table 22

Preferred Learning Style by Academic Major (n=103)

<table>
<thead>
<tr>
<th>Gender</th>
<th>Field-Dependence</th>
<th>GEFT</th>
<th>Field-Independence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Freq.</td>
<td>%</td>
<td>Freq.</td>
</tr>
<tr>
<td>Animal Science</td>
<td>8</td>
<td>29.6</td>
<td>19</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td>11</td>
<td>52.4</td>
<td>10</td>
</tr>
<tr>
<td>Horticulture</td>
<td>7</td>
<td>43.8</td>
<td>9</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>1</td>
<td>9.1</td>
<td>10</td>
</tr>
<tr>
<td>Food Science</td>
<td>3</td>
<td>37.5</td>
<td>5</td>
</tr>
<tr>
<td>Dairy Science</td>
<td>1</td>
<td>14.3</td>
<td>6</td>
</tr>
<tr>
<td>Agronomy</td>
<td>5</td>
<td>71.4</td>
<td>2</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>3</td>
<td>75.0</td>
<td>1</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanics</td>
<td>1</td>
<td>50.0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>38.8</td>
<td>63</td>
</tr>
</tbody>
</table>

Agricultural Economics

Of the 21 senior students majoring in Agricultural Economics, 52.4 percent (n=11) leaned toward the field dependent learning style and 47.6 percent (n=10) leaned toward
the field independent learning style (Table 22). The raw GEFT scores ranged from 4 to 18. The mean raw GEFT score was 11.1 with a standard deviation of 4.65 (Table 23).

Horticulture

Of the 16 senior students majoring in Horticulture, 43.8 percent (n=7) leaned toward the field dependent learning style and 56.2 percent (n=9) leaned toward the field independent learning style (Table 22). The raw GEFT scores ranged from 3 to 18. The mean raw GEFT score was 12.1 with a standard deviation of 4.69 (Table 23).

Agricultural Education

Of the 11 senior students majoring in Agricultural Education, 9.1 percent (n=1) leaned toward the field dependent learning style and 90.1 percent (n=10) leaned toward the field independent learning style (Table 22). The raw GEFT scores ranged from 9 to 18. The mean raw GEFT score was 15.6 with a standard deviation of 2.70 (Table 23).

Food Science

Of the 8 senior students majoring in Food Science, 37.5 percent (n=3) leaned toward the field dependent learning style and 62.5 percent (n=5) leaned toward the field independent learning style (Table 22). The raw GEFT scores ranged from 1 to 17. The mean raw GEFT score was 11.3 with a standard deviation of 5.23 (Table 23).
Dairy Science

Of the 7 senior students majoring in Dairy Science, 14.3 percent (n=1) leaned toward the field dependent learning style and 85.7 percent (n=6) leaned toward the field independent learning style (Table 22). The raw GEFT scores ranged from 11 to 17. The mean raw GEFT score was 13.7 with a standard deviation of 2.29 (Table 23).

Agronomy

Of the 7 senior students majoring in Agronomy, 71.4 percent (n=5) leaned toward the field dependent learning style and 28.6 percent (n=2) leaned toward the field independent learning style (Table 22). The raw GEFT scores ranged from 10 to 17. The mean raw GEFT score was 12.3 with a standard deviation of 2.63 (Table 23).

Agricultural Communication

Of the 4 senior students majoring in Agricultural Communication, 75.0 percent (n=3) leaned toward the field dependent learning style and 25.0 percent (n=1) leaned toward the field independent learning style (Table 22). The raw GEFT scores ranged from 2 to 15. The mean raw GEFT score was 8.8 with a standard deviation of 5.38 (Table 23).

Agricultural Mechanics

Of the 2 senior students majoring in Agricultural Mechanics, one leaned (50.0%) toward the field dependent learning style and one leaned (50.0%) toward the field independent learning style (Table 22). The raw GEFT scores
ranged from 8 to 13. The mean raw GEFT score was 10.5 with a standard deviation of 3.54 (Table 23).

Table 23

<table>
<thead>
<tr>
<th>Major</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Science</td>
<td>27</td>
<td>13.1</td>
<td>3.99</td>
<td>2 - 18</td>
</tr>
<tr>
<td>Agricultural Economics</td>
<td>21</td>
<td>11.1</td>
<td>4.65</td>
<td>4 - 18</td>
</tr>
<tr>
<td>Horticulture</td>
<td>16</td>
<td>12.1</td>
<td>4.69</td>
<td>3 - 18</td>
</tr>
<tr>
<td>Agricultural Education</td>
<td>11</td>
<td>15.6</td>
<td>2.70</td>
<td>9 - 18</td>
</tr>
<tr>
<td>Food Science</td>
<td>8</td>
<td>11.3</td>
<td>5.23</td>
<td>1 - 17</td>
</tr>
<tr>
<td>Dairy Science</td>
<td>7</td>
<td>13.7</td>
<td>2.29</td>
<td>11 - 17</td>
</tr>
<tr>
<td>Agronomy</td>
<td>7</td>
<td>12.3</td>
<td>2.63</td>
<td>10 - 17</td>
</tr>
<tr>
<td>Agricultural Communication</td>
<td>4</td>
<td>8.8</td>
<td>5.38</td>
<td>2 - 15</td>
</tr>
<tr>
<td>Agricultural Mechanics</td>
<td>2</td>
<td>10.5</td>
<td>3.54</td>
<td>8 - 13</td>
</tr>
</tbody>
</table>

Note. Based on Raw Scores (total possible score = 18)
Correlates of Students' Cognitive Abilities

Students' Characteristics

Pearson product-moment correlations coefficients (r) were calculated to describe the relationship between senior students' cognitive abilities (Basic Cognitive Abilities, Application Abilities, Critical Thinking Abilities) as measured by the DCAT and interval variables: age, cumulative GPA, and ACT composite score. Point-biserial correlations coefficients (rpb) were calculated to describe the relationship between senior students' cognitive abilities (Basic Cognitive Abilities, Application Abilities, Critical Thinking Abilities) and gender (nominal/categorical data). To compute point-biserial correlations coefficients, gender was Dummy coded. Davis' (1971) conventions were used to interpret the magnitude of all relationships described. All correlations coefficients are based on an n=103 with the exception of ACT composite score correlates. ACT composite score correlation coefficients are based on an n=84.

Basic Cognitive Abilities

The correlation coefficients between senior students' Basic Cognitive Abilities score and their characteristics (age, gender, cumulative GPA, ACT composite score) are presented in Table 24. The relationship between the senior students' age and Basic Cognitive Abilities score was positive, but negligible (r=.03). The relationship between senior students' gender and Basic Cognitive Abilities score
was positive, but negligible ($r_{pb} = .10$). There was a significant and substantial positive relationship ($r = .53; p < .05$) between senior students' cumulative GPA and Basic Cognitive Abilities score. In addition, there was a significant and substantial positive relationship ($r = .54; p < .05$) between senior students' ACT composite score and Basic Cognitive Abilities score.

Table 24

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Cognitive Abilities</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Application</td>
</tr>
<tr>
<td>Age</td>
<td>.03</td>
<td>-.02</td>
</tr>
<tr>
<td>Gender(^a)</td>
<td>.10</td>
<td>.25*</td>
</tr>
<tr>
<td>Cumulative GPA</td>
<td>.53*</td>
<td>.49*</td>
</tr>
<tr>
<td>ACT Composite(^b)</td>
<td>.54*</td>
<td>.46*</td>
</tr>
</tbody>
</table>

Note. Coefficients reported as Pearson Product Moment Correlations
a: Point-biserial Correlation; Female = 0, Male = 1
b: Based on $n = 84$
* $p < .05$

Application Abilities

The correlation coefficients between senior students' Application Abilities score and their characteristics (age,
gender, cumulative GPA, ACT composite score) are presented in Table 24. The relationship between the senior students' age and Application Abilities score was negative, but negligible ($r = -0.02$). A significant and positive low relationship ($r_{pb} = 0.25; p < 0.05$) existed between senior students' gender and Application Abilities score. Similarly, there was a significant and moderate positive relationship ($r = 0.49; p < 0.05$) between senior students' cumulative GPA and Application Abilities score. In addition, there was a significant and moderate positive relationship ($r = 0.46; p < 0.05$) between senior students' ACT composite score and Application Abilities score (Table 24).

**Critical Thinking Abilities**

The correlation coefficients between senior students' Critical Thinking Abilities score and their characteristics (age, gender, cumulative GPA, ACT composite score) are presented in Table 24. The relationship between the senior students' age and Critical Thinking Abilities score was negative, but negligible ($r = -0.08$). A negative negligible relationship ($r_{pb} = -0.02$) existed between senior students' gender and Critical Thinking Abilities score. There was a significant and moderate positive relationship ($r = 0.33; p < 0.05$) between senior students' cumulative GPA and Critical Thinking Abilities score. Likewise, there was a significant and moderate positive relationship ($r = 0.40; p < 0.05$) between senior...
students' ACT composite score and Critical Thinking Abilities score (Table 24).

**Regression of Basic Cognitive Abilities**

Multiple regression analysis was utilized to determine the proportion of variance in Basic Cognitive Abilities score that can be explained by its linear relationship with student characteristics (age, gender, cumulative GPA). ACT composite score was not included in the multiple regression because of missing data (n=84). Gender was Dummy coded to represent senior students as either male or female.

Senior student characteristics were entered into the multiple regression model simultaneously. A multiple coefficient of correlation (Multiple R) was calculated for students' Basic Cognitive Abilities score and senior students' characteristics (age, gender, cumulative GPA) (R=.55) and was interpreted as a positive substantial correlation between senior students' predicted Basic Cognitive Abilities score (derived from students' characteristics) and the observed Basic Cognitive Abilities score (Table 25).

By squaring Multiple R (R²), the correlation coefficient becomes a coefficient of determination (the estimated proportion of variance in Basic Cognitive Abilities score accounted by the linear combination of senior students' characteristics). It was found that students' characteristics explained 31 percent of the variance in Basic Cognitive Abilities score (F=14.76; p<.05) (Table 25). In general, R²
calculated on a sample tends to overestimate the population \( R^2 \). An adjusted \( R^2 \) was calculated (.29) in attempt to correct the optimistic bias of the sample \( R^2 \).

Table 25

Regression of Developing Cognitive Abilities Test - Basic Cognitive Abilities on Student Characteristics (n=103) 
(Simultaneous Entry)

<table>
<thead>
<tr>
<th>Variable</th>
<th>R</th>
<th>( R^2 )</th>
<th>b</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
<td>.55</td>
<td>.31</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>.01</td>
<td>.08</td>
<td>.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender*</td>
<td>.40</td>
<td>.64</td>
<td>.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative GPA</td>
<td>3.45</td>
<td>6.49</td>
<td>.01*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>10.02</td>
<td>4.40</td>
<td>.01*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjusted \( R^2 = .29 \)
For Model: \( F = 14.67; \ p<.05 \)

*Female = 0, Male = 1

*p<.05

Table 25 displays the regression weights (b) for the senior students' characteristics (age, gender, cumulative GPA). The regression weights were interpreted as the predicted change in Basic Cognitive Abilities score corresponding to a unit change in the independent variable in question; holding all other variables constant. The constant is equal to the predicted Basic Cognitive Abilities score when
all independent variables (age, gender, cumulative GPA) are zero.

The predicted change in Basic Cognitive Abilities score will increase .01 unit for every unit increase in age \((b=.01)\) holding gender and cumulative GPA constant. The difference between gender \((b=.04)\) is .40 units in Basic Cognitive Abilities score holding age and cumulative GPA constant. The predicted change in Basic Cognitive Abilities score will increase 3.45 units for every unit increase in cumulative GPA \((b=3.45)\) holding age and gender constant.

**Regression of Application Abilities**

Multiple regression analysis was utilized to determine the proportion of variance in Application Abilities score that could be explained by its linear relationship with student characteristics (age, gender, cumulative GPA). ACT composite score was not included in the multiple regression because of missing data \((n=84)\). Gender was Dummy coded to represent senior students as either male or female.

Senior student characteristics were entered into the multiple regression model simultaneously. A multiple coefficient of correlation (Multiple R) was calculated for students' Application Abilities score and senior students' characteristics \((Age, gender, cumulative GPA) (R=.54)\) and was interpreted as a positive substantial correlation between senior students' predicted Application Abilities score
(derived from students' characteristics) and the observed Application Abilities score (Table 26).

By squaring Multiple R ($R^2$), the correlation coefficient becomes a coefficient of determination (the estimated proportion of variance in Application Abilities score accounted by the linear combination of senior students' characteristics). It was found that students' characteristics explained 29 percent of the variance in Application Abilities score ($F=13.23; p<.05$) (Table 26). In general, $R^2$ calculated on a sample tends to overestimate the population $R^2$. An adjusted $R^2$ was calculated (.26) in attempt to correct the optimistic bias of the sample $R^2$.

Table 26 displays the regression weights (b) for the senior students' characteristics (age, gender, cumulative GPA). The regression weights were interpreted as the predicted change in Application Abilities score corresponding to a unit change in the independent variable in question; holding all other variables constant. The constant is equal to the predicted Application Abilities score when all independent variables (age, gender, cumulative GPA) are zero.

The predicted change in Application Abilities score will decrease .01 unit for every unit increase in age ($b=-.01$) holding gender and cumulative GPA constant. The difference between gender ($b=1.33$) is 1.33 units in Application Abilities score holding age and cumulative GPA constant. The predicted change in Application Abilities score will increase 2.64 units
for every unit increase in cumulative GPA (b=2.64) holding age and gender constant.

Table 26

Regression of Developing Cognitive Abilities Test – Application Abilities on Student Characteristics (n=103) (Simultaneous Entry)

<table>
<thead>
<tr>
<th>Variable</th>
<th>R</th>
<th>R²</th>
<th>b</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
<td>.54</td>
<td>.29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-.01</td>
<td>-.14</td>
<td>.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender*a</td>
<td>1.33</td>
<td>2.39</td>
<td>.02*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative GPA</td>
<td>2.64</td>
<td>5.56</td>
<td>.01*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>12.23</td>
<td>6.11</td>
<td>.01*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjusted R² = .26
For Model: F = 12.42; p<.05
a: Female = 0, Male = 1
*p<.05

Regression of Critical Thinking Abilities

Multiple regression analysis was utilized to determine the proportion of variance in Critical Thinking Abilities score that could be explained by its linear relationship with student characteristics (age, gender, cumulative GPA). ACT composite score was not included in the multiple regression because of missing data (n=84). Gender was Dummy coded to represent senior students as either male or female.
Senior student characteristics were entered into the multiple regression model simultaneously. A multiple coefficient of correlation (Multiple R) was calculated for students' Critical Thinking Abilities score and senior students' characteristics (age, gender, cumulative GPA) (R=.35) and was interpreted as a positive moderate correlation between senior students' predicted Critical Thinking Abilities score (derived from students' characteristics) and the observed Critical Thinking Abilities score (Table 27).

By squaring Multiple R (R²), the correlation coefficient becomes a coefficient of determination (the estimated proportion of variance in Critical Thinking Abilities score accounted by the linear combination of senior students' characteristics). It was found that students' characteristics explained 12 percent of the variance in Critical Thinking Abilities score (F=4.71; p<.05) (Table 27). In general, R² calculated on a sample tends to overestimate the population R². An adjusted R² was calculated (.10) in attempt to correct the optimistic bias of the sample R².

Table 27 displays the regression weights (b) for the senior students' characteristics (age, gender, cumulative GPA). The regression weights were interpreted as the predicted change in Critical Thinking Abilities score corresponding to a unit change in the independent variable in question; holding all other variables constant. The constant is equal to the predicted Critical Thinking Abilities score
when all independent variables (age, gender, cumulative GPA) are zero.

Table 27

Regression of Developing Cognitive Abilities Test - Critical Thinking Abilities on Student Characteristics (n=103) (Simultaneous Entry)

<table>
<thead>
<tr>
<th>Variable</th>
<th>R</th>
<th>R²</th>
<th>b</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
<td>.35</td>
<td>.12</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-.11</td>
<td>-.12</td>
<td>-1.20</td>
<td>.24</td>
<td></td>
</tr>
<tr>
<td>Gender*</td>
<td>-.55</td>
<td>-.72</td>
<td>-</td>
<td>.47</td>
<td></td>
</tr>
<tr>
<td>Cumulative GPA</td>
<td>2.38</td>
<td>3.64</td>
<td>.01*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>13.19</td>
<td>4.71</td>
<td>.01*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjusted $R^2 = .10$
For Model: $F = 4.71; p<.05$
a: Female = 0, Male = 1
* $p<.05$

The predicted change in Critical Thinking Abilities score will decrease .11 unit for every unit increase in age (b=-.11) holding gender and cumulative GPA constant. The difference between gender is .55 units in Critical Thinking Abilities score holding age and cumulative GPA constant. The predicted change in Critical Thinking Abilities score will increase 2.38 units for every unit increase in cumulative GPA (b=2.38) holding age and gender constant.
**Academic Major**

Point-biserial correlation coefficients ($r_{pb}$) were calculated to describe the relationship between cognitive abilities (Basic Cognitive Abilities, Application Abilities, Critical Thinking Abilities) and each of the nine (9) academic majors: Animal Science, Agricultural Economics, Horticulture, Agricultural Education, Food Science, Dairy Science, Agronomy, Agricultural Education, Agricultural Mechanics. Academic majors were dummy coded to represent presence in the major in question (Major) and presence in an other major (Other Major).

**Basic Cognitive Abilities**

Table 28 presents point-biserial correlation coefficients to describe the relationship between Basic Cognitive Abilities score and the nine (9) academic majors. The relationship between Basic Cognitive Abilities score and senior students majoring in Animal Science (n=27) was positive, but negligible ($r_{pb}=.09$). A negative low relationship ($r_{pb}=-.11$) existed between Basic Cognitive Abilities score and students majoring in Agricultural Economics (n=21). Similarly, a negative low relationship ($r_{pb}=-.18$) existed between Basic Cognitive Abilities score and students majoring in Horticulture (n=16). A positive, but negligible relationship ($r_{pb}=.07$) existed between Basic Cognitive Abilities score and students majoring in Agricultural Education (n=11).
Table 28

Relationship Between Developing Cognitive Abilities Test - Basic Cognitive Abilities and Academic Major (n=103)

<table>
<thead>
<tr>
<th>Major*</th>
<th>n</th>
<th>Basic Cognitive Abilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Science</td>
<td>27</td>
<td>.09</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td>21</td>
<td>-.11</td>
</tr>
<tr>
<td>Horticulture</td>
<td>16</td>
<td>-.18</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>11</td>
<td>.07</td>
</tr>
<tr>
<td>Food Science</td>
<td>8</td>
<td>.04</td>
</tr>
<tr>
<td>Dairy Science</td>
<td>7</td>
<td>.18</td>
</tr>
<tr>
<td>Agronomy</td>
<td>7</td>
<td>-.03</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>4</td>
<td>-.03</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanics</td>
<td>2</td>
<td>.06</td>
</tr>
</tbody>
</table>

Note. Coefficients reported as Point-biserial Correlations
a: Other Major = 0, Major = 1
*p<.05

Likewise, a positive negligible relationship ($r_{pb}=.04$) existed between Basic Cognitive Abilities score and students majoring in Food Science (n=8). A positive low relationship ($r_{pb}=.18$) existed between Basic Cognitive Abilities score and students majoring in Dairy Science (n=7). A negative
negligible relationship \( r_{pb} = -0.03 \) existed between Basic Cognitive Abilities score and students majoring in Agronomy \( (n=7) \).

Similarly, a negative negligible relationship \( r_{pb} = -0.03 \) existed between Basic Cognitive Abilities score and students majoring in Agricultural Communication \( (n=4) \). A positive negligible relationship \( r_{pb} = 0.06 \) existed between Basic Cognitive Abilities score and students majoring in Agricultural Mechanics \( (n=2) \). None of the point-biserial correlation coefficients calculated to describe the relationship between students Basic Cognitive Abilities score and academic major were significant \( (p<0.05) \) (Table 28).

Multiple regression analysis was utilized to describe the relationship between Basic Cognitive Abilities score and academic major (Table 29). Dummy variables were generated to represent presence in each major in question and were entered into the multiple regression model simultaneously. The number of Dummy variables generated \( (k-1) \) was eight. In the analysis, the major - Animal Science was held constant because it represented the largest number of students \( (n=27) \).

A multiple coefficient of correlation (Multiple R) was calculated for students' Basic Cognitive Abilities score and academic major \( (R=0.29) \) and was interpreted as a positive low correlation between senior students' predicted Basic Cognitive Abilities score (derived from academic major) and the observed Basic Cognitive Abilities score (Table 29).
Table 29

Regression of Developing Cognitive Abilities Test - Basic Cognitive Abilities on Academic Major (n=103) (Simultaneous Entry)

<table>
<thead>
<tr>
<th>Variable</th>
<th>R</th>
<th>R²</th>
<th>b</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major</td>
<td>.29</td>
<td>.08</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td>-1.27</td>
<td>-1.21</td>
<td>.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horticulture</td>
<td>-2.05</td>
<td>-1.81</td>
<td>.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>.18</td>
<td>.14</td>
<td>.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Science</td>
<td>.00</td>
<td>.00</td>
<td>.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy Science</td>
<td>1.91</td>
<td>1.25</td>
<td>.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agronomy</td>
<td>-.94</td>
<td>-.62</td>
<td>.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>-1.12</td>
<td>-.78</td>
<td>.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanics</td>
<td>1.12</td>
<td>-.58</td>
<td>.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>20.37</td>
<td>29.30</td>
<td>.01*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjusted R² = .01
For Model: F = 1.09; p > .05
*p < .05

By squaring Multiple R (R²), the correlation coefficient becomes a coefficient of determination (the estimated
proportion of variance in Basic Cognitive Abilities score accounted by the linear combination of the eight academic majors). It was found that academic major explained eight percent of the variance in Basic Cognitive Abilities score (Table 29). However, the regression model was not significant ($F=1.09; p>.05$).

**Application Abilities**

Table 30 presents point-biserial correlation coefficients to describe the relationship between Application Abilities score and academic major. The relationship between Application Abilities score and senior students majoring in Animal Science ($n=27$) was negative and low ($r_{pb}=-.10$). A negative low relationship ($r_{pb}=-.10$) also existed between Application Abilities score and students majoring in Agricultural Economics ($n=21$). A negative negligible relationship ($r_{pb}=-.03$) existed between Application Abilities score and students majoring in Horticulture ($n=16$). A significant and positive low relationship ($r_{pb}=.25; p<.05$) existed between Application Abilities score and students majoring in Agricultural Education ($n=11$).

A positive negligible relationship ($r_{pb}=.05$) existed between Application Abilities score and students majoring in Food Science ($n=8$). A positive negligible relationship ($r_{pb}=.09$) existed between Application Abilities score and students majoring in Dairy Science ($n=7$). A positive negligible relationship ($r_{pb}=.03$) also existed between
Application Abilities score and students majoring in Agronomy (n=7).

Table 30

Relationship Between Developing Cognitive Abilities Test - Application Abilities and Academic Major (n=103)

<table>
<thead>
<tr>
<th>Major</th>
<th>n</th>
<th>Application Abilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Science</td>
<td>27</td>
<td>-0.10</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td>21</td>
<td>-0.10</td>
</tr>
<tr>
<td>Horticulture</td>
<td>16</td>
<td>-0.03</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>11</td>
<td>0.25*</td>
</tr>
<tr>
<td>Food Science</td>
<td>8</td>
<td>0.05</td>
</tr>
<tr>
<td>Dairy Science</td>
<td>7</td>
<td>0.09</td>
</tr>
<tr>
<td>Agronomy</td>
<td>7</td>
<td>0.03</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>4</td>
<td>-0.17</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanics</td>
<td>2</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Note. Coefficients reported as Point-biserial Correlations
a: Other Major = 0, Major = 1
*p<.05
In addition, a negative low relationship ($r_{pb} = -.17$) existed between Application Abilities score and students majoring in Agricultural Communication ($n=4$). A positive negligible relationship ($r_{pb} = .04$) existed between Application Abilities score and students majoring in Agricultural Mechanics ($n=2$). With the exception of Agricultural Education, none of the point-biserial correlation coefficients calculated to describe the relationship between students Application Abilities score and academic major were significant ($p<.05$).

Multiple regression analysis was utilized to describe the relationship between Application Abilities score and academic major (Table 31). The Dummy variables were generated to represent presence in each major in question and were entered into the multiple regression model simultaneously. The number of Dummy variables generated ($k-1$) was eight. In the analysis, the major - Animal Science was held constant because it represented the largest number of students ($n=27$).

A multiple coefficient of correlation (Multiple R) was calculated for students' Application Abilities score and academic major ($R=.34$) and was interpreted as positive moderate correlation between senior students' predicted Application Abilities score (derived from academic major) and the observed Application Abilities score (Table 31).
Table 31

Regression of Developing Cognitive Abilities Test - Application Abilities on Academic Major (n=103) (Simultaneous Entry)

<table>
<thead>
<tr>
<th>Variable</th>
<th>R</th>
<th>R^2</th>
<th>b</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td>-.10</td>
<td>-.11</td>
<td>.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horticulture</td>
<td>.27</td>
<td>.28</td>
<td>.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural Education</td>
<td>2.88</td>
<td>2.57</td>
<td>.01*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Science</td>
<td>1.08</td>
<td>.86</td>
<td>.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy Science</td>
<td>1.62</td>
<td>1.22</td>
<td>.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agronomy</td>
<td>.90</td>
<td>.68</td>
<td>.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>-2.17</td>
<td>-1.30</td>
<td>.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanics</td>
<td>1.33</td>
<td>.58</td>
<td>.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>19.67</td>
<td>32.73</td>
<td>.01*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjusted R^2 = .04
For Model: F = 1.53; p > .05
*p < .05

By squaring Multiple R (R^2), the correlation coefficient becomes a coefficient of determination (the estimated proportion of variance in Application Abilities score accounted by the linear combination of the eight academic
majors). It was found that academic major explained 12 percent of the variance in Application Abilities score (Table 31). However, the regression model was not significant ($F=1.53$; $p>.05$).

**Critical Thinking Abilities**

Table 32 presents point-biserial correlation coefficients to describe the relationship between Critical Thinking Abilities score and academic major. The relationship between Critical Thinking Abilities score and senior students majoring in Animal Science ($n=27$) was positive, but negligible ($r_{pb}=.09$). A negative negligible relationship ($r_{pb}=-.02$) existed between Critical Thinking Abilities score and students majoring in Agricultural Economics ($n=21$). Similarly, a negative negligible relationship ($r_{pb}=-.08$) existed between Critical Thinking Abilities score and students majoring in Horticulture ($n=16$). A positive low relationship ($r_{pb}=.12$) existed between Critical Thinking Abilities score and students majoring in Agricultural Education ($n=11$).

A negative negligible relationship ($r_{pb}=-.03$) existed between Critical Thinking Abilities score and students majoring in Food Science ($n=8$). A negative negligible relationship ($r_{pb}=-.02$) also existed between Critical Thinking Abilities score and students majoring in Dairy Science ($n=7$). A negative low relationship ($r_{pb}=-.11$) existed between Critical Thinking Abilities score and students majoring in Agronomy ($n=7$).
<table>
<thead>
<tr>
<th>Major*</th>
<th>n</th>
<th>Critical Thinking Abilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Science</td>
<td>27</td>
<td>.09</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td>21</td>
<td>-.02</td>
</tr>
<tr>
<td>Horticulture</td>
<td>16</td>
<td>-.08</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>11</td>
<td>.12</td>
</tr>
<tr>
<td>Food Science</td>
<td>8</td>
<td>-.03</td>
</tr>
<tr>
<td>Dairy Science</td>
<td>7</td>
<td>-.02</td>
</tr>
<tr>
<td>Agronomy</td>
<td>7</td>
<td>-.11</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>4</td>
<td>-.03</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanics</td>
<td>2</td>
<td>.06</td>
</tr>
</tbody>
</table>

**Note.** Coefficients reported as Point-biserial Correlations  
* a: Other Major = 0, Major = 1  
* p<.05

A negative negligible relationship ($r_{pb}=-.03$) existed between Critical Thinking Abilities score and students majoring in Agricultural Communication (n=4). A positive negligible relationship ($r_{pb}=.06$) existed between Critical
Thinking Abilities score and students majoring in Agricultural Mechanics (n=2). None of the point-biserial correlation coefficients calculated to describe the relationship between students Critical Thinking Abilities score and academic major were significant (p<.05).

Multiple regression analysis was utilized to describe the relationship between Critical Thinking Abilities score and academic major (Table 33). Dummy variables were generated to represent presence in each major in question and were entered into the multiple regression model simultaneously. The number of Dummy variables generated (k-1) was eight. In the analysis, the major - Animal Science was held constant because it represented the largest number of students (n=27).

A multiple coefficient of correlation (Multiple R) was calculated for students' Critical Thinking Abilities score and academic major (R=.21) and was interpreted as positive low correlation between senior students' predicted Critical Thinking Abilities score (derived from academic major) and the observed Critical Thinking Abilities score (Table 33).

By squaring Multiple R (R²), the correlation coefficient becomes a coefficient of determination (the estimated proportion of variance in Critical Thinking Abilities score accounted by the linear combination of the eight academic majors). It was found that academic major explained four percent of the variance in Critical Thinking Abilities score
(Table 33). However, the regression model was not significant (F=.55; p>.05).

Table 33

Regression of Developing Cognitive Abilities Test - Critical Thinking Abilities on Academic Major (n=103) (Simultaneous Entry)

<table>
<thead>
<tr>
<th>Variable</th>
<th>R</th>
<th>R²</th>
<th>b</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major</td>
<td>.21</td>
<td>.04</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td>-.79</td>
<td>-.67</td>
<td>.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horticulture</td>
<td>-1.34</td>
<td>-1.06</td>
<td>.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>.87</td>
<td>.06</td>
<td>.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Science</td>
<td>-1.03</td>
<td>-.64</td>
<td>.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy Science</td>
<td>-.98</td>
<td>-.57</td>
<td>.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agronomy</td>
<td>-2.26</td>
<td>-1.32</td>
<td>.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>-1.18</td>
<td>-.54</td>
<td>.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanics</td>
<td>1.09</td>
<td>.04</td>
<td>.71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>17.40</td>
<td>22.42</td>
<td>.01*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjusted R² = -.04
For Model: F = .55; p>.05
*p<.05
Correlates of Students' Learning Style

Student Characteristics

Pearson product-moment correlations coefficients (r) were calculated to describe the relationship between senior students' preferred learning style as measured by the GEFT and interval variables: age, cumulative GPA, and ACT composite score. Point-biserial correlations coefficients (r_{pb}) were calculated to describe the relationship between senior students' GEFT score and gender (nominal/categorical data). To compute point-biserial correlations coefficients, gender was Dummy coded. Davis' (1971) conventions were used to interpret the magnitude of all relationships described. All correlations coefficients are based on an n=103 with the exception of ACT composite score correlates. ACT composite scores are based on an n=84.

The correlation coefficients between senior students' GEFT score and their characteristics are presented in Table 34. The relationship between the senior students' age and GEFT score was negative and low (r=-.19). A significant and low positive relationship (r_{pb}=.26; p<.05) existed between senior students' gender and GEFT score. Additionally, there was a significant and moderate positive relationship (r=.34; p<.05) between senior students' cumulative GPA and GEFT score. Furthermore, there was a significant and moderate positive relationship (r=.34; p<.05) between senior students' ACT composite score and GEFT score.
Table 34

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>GEFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-.19</td>
</tr>
<tr>
<td>Gender*</td>
<td>.26*</td>
</tr>
<tr>
<td>Cumulative GPA</td>
<td>.34*</td>
</tr>
<tr>
<td>ACT Compositeb</td>
<td>.34*</td>
</tr>
</tbody>
</table>

Note. Coefficients reported as Pearson Product Moment Correlations  
a: Point-biserial Correlation; Female = 0, Male = 1  
b: Based on n = 84  
*p<.05

Multiple regression analysis was utilized to determine the proportion of variance in GEFT score that could be explained by its linear relationship with student characteristics (age, gender, cumulative GPA) (Table 35). ACT composite score was not included in the multiple regression because of missing data (n=84). Gender was Dummy coded to represent senior students as either male or female.

Senior student characteristics were entered into the multiple regression model simultaneously. A multiple coefficient of correlation (Multiple R) was calculated for students' GEFT score and senior students' characteristics (age, gender, cumulative GPA) (R=.36) and was interpreted as
a positive moderate correlation between senior students' predicted GEFT score (derived from students' characteristics) and the observed GEFT score (Table 35).

By squaring Multiple R ($R^2$), the correlation coefficient becomes a coefficient of determination (the estimated proportion of variance in GEFT score accounted by the linear combination of senior students' characteristics). It was found that students' characteristics explained 13 percent of the variance in GEFT score ($F=5.02; p<.05$) (Table 35). In general, $R^2$ calculated on a sample tends to overestimate the population $R^2$. An adjusted $R^2$ was calculated (.11) in attempt to correct the optimistic bias of the sample $R^2$.

Table 35

Regression of GEFT Score on Student Characteristics (n=103) (Simultaneous Entry)

<table>
<thead>
<tr>
<th>Variable</th>
<th>R</th>
<th>$R^2$</th>
<th>b</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
<td>.36</td>
<td>.13</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-.03</td>
<td>- .28</td>
<td>.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gendera</td>
<td>2.00</td>
<td>2.44</td>
<td>.01*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative GPA</td>
<td>1.90</td>
<td>2.71</td>
<td>.01*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>6.71</td>
<td>2.24</td>
<td>.01*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjusted $R^2 = .11$  
For Model: $F = 5.02; p<.05$  
a: Female = 0, Male = 1  
*p<.05
Table 35 displays the regression weights (b) for the senior students' characteristics (age, gender, cumulative GPA). The regression weights were interpreted as the predicted change in GEFT score corresponding to a unit change in the independent variable in question; holding all other variables constant. The constant is equal to the predicted GEFT score when all independent variables (age, gender, cumulative GPA) are zero.

The predicted change in GEFT score will decrease .03 unit for every unit increase in age (b=-.03) holding gender and cumulative GPA constant. The difference between gender (b=2.00) is 2.00 units in GEFT score holding age and cumulative GPA constant. The predicted change in GEFT score will increase 1.90 units for every unit increase in cumulative GPA (b=1.90) holding age and gender constant.

**Academic Major**

Point-biserial correlation coefficients ($r_{pb}$) were calculated to describe the relationship between senior students' GEFT score and each of the nine (9) academic majors: Animal Science, Agricultural Economics, Horticulture, Agricultural Education, Food Science, Dairy Science, Agronomy, Agricultural Education, Agricultural Mechanics. Academic majors were Dummy coded to represent presence in the major in question (Major) and presence in an other major (Other Major).
Table 36 presents point-biserial correlation coefficients to describe the relationship between GEFT score and the nine (9) academic majors. The relationship between GEFT score and senior students majoring in Animal Science (n=27) was positive, but negligible ($r_{pb} = .09$). A negative low relationship ($r_{pb} = -.16$) existed between GEFT score and students majoring in Agricultural Economics (n=21). Similarly, a negative negligible relationship ($r_{pb} = -.03$) existed between GEFT score and students majoring in Horticulture (n=16). A positive low relationship ($r_{pb} = .25$) existed between GEFT score and students majoring in Agricultural Education (n=11).

Likewise, a negative negligible relationship ($r_{pb} = -.08$) existed between GEFT score and students majoring in Food Science (n=8). A positive negligible relationship ($r_{pb} = .08$) existed between GEFT score and students majoring in Dairy Science (n=7). A negative negligible relationship ($r_{pb} = -.01$) existed between GEFT score and students majoring in Agronomy (n=7). Similarly, a negative low relationship ($r_{pb} = -.17$) existed between GEFT score and students majoring in Agricultural Communication (n=4). A negative negligible relationship ($r_{pb} = -.06$) existed between GEFT score and students majoring in Agricultural Mechanics (n=2). None of the point-biserial correlation coefficients calculated to describe the relationship between students GEFT score and academic major were significant (p<.05).
Table 36

**Relationship Between Learning Style and Academic Major (n=103)**

<table>
<thead>
<tr>
<th>Major</th>
<th>n</th>
<th>GEFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal Science</td>
<td>27</td>
<td>.09</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td>21</td>
<td>-.16</td>
</tr>
<tr>
<td>Horticulture</td>
<td>16</td>
<td>-.03</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>11</td>
<td>.25</td>
</tr>
<tr>
<td>Food Science</td>
<td>8</td>
<td>-.08</td>
</tr>
<tr>
<td>Dairy Science</td>
<td>7</td>
<td>.08</td>
</tr>
<tr>
<td>Agronomy</td>
<td>7</td>
<td>-.01</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>4</td>
<td>-.17</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanics</td>
<td>2</td>
<td>-.06</td>
</tr>
</tbody>
</table>

**Note.** Coefficients reported as Point-biserial Correlations
a: Other Major = 0, Major = 1
* p<.05

Multiple regression analysis was utilized to describe the relationship between GEFT score and academic major (Table 37). Dummy variables were generated to represent presence in each major in question and were entered into the multiple regression model simultaneously. The number of Dummy
variables generated (k-1) was eight. In the analysis, the major - Animal Science was held constant because it represented the largest number of students (n=27).

Table 37

<table>
<thead>
<tr>
<th>Variable</th>
<th>R</th>
<th>R²</th>
<th>b</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major</td>
<td>.37</td>
<td>.37</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural Economics</td>
<td></td>
<td></td>
<td>-2.03</td>
<td>-1.68</td>
<td>.10</td>
</tr>
<tr>
<td>Horticulture</td>
<td></td>
<td></td>
<td>-.95</td>
<td>-.73</td>
<td>.47</td>
</tr>
<tr>
<td>Agricultural Education</td>
<td></td>
<td></td>
<td>2.56</td>
<td>1.73</td>
<td>.09</td>
</tr>
<tr>
<td>Food Science</td>
<td></td>
<td></td>
<td>-1.82</td>
<td>-1.10</td>
<td>.28</td>
</tr>
<tr>
<td>Dairy Science</td>
<td></td>
<td></td>
<td>.64</td>
<td>.37</td>
<td>.72</td>
</tr>
<tr>
<td>Agronomy</td>
<td></td>
<td></td>
<td>-.79</td>
<td>-.45</td>
<td>.65</td>
</tr>
<tr>
<td>Agricultural Communication</td>
<td></td>
<td></td>
<td>-4.32</td>
<td>-1.95</td>
<td>.05*</td>
</tr>
<tr>
<td>Agricultural Mechanics</td>
<td></td>
<td></td>
<td>-2.57</td>
<td>-.85</td>
<td>.40</td>
</tr>
<tr>
<td>(Constant)</td>
<td></td>
<td></td>
<td>13.07</td>
<td>16.42</td>
<td>.01*</td>
</tr>
</tbody>
</table>

Adjusted R² = .06
For Model: F = 1.83; p>.05
*p<.05
A multiple coefficient of correlation (Multiple R) was calculated for students' GEFT score and academic major (R=.37) and was interpreted as positive moderate correlation coefficient between senior students' predicted GEFT score (derived from academic major) and the observed GEFT score (Table 37).

By squaring Multiple R (R^2), the correlation coefficient becomes a coefficient of determination (the estimated proportion of variance in GEFT score accounted by the linear combination of the eight academic majors). It was found that academic major explained 13 percent of the variance in GEFT score (Table 37). However, the regression model was not significant (F=1.83; p>.05).

**Relationship Between Cognitive Abilities and Learning Style of Students**

Pearson product-moment correlation coefficients (r) were computed to describe the relationship between cognitive abilities (Basic Cognitive Abilities, Application Abilities, Critical Thinking Abilities) and GEFT score (Table 38).

A significant and positive moderate relationship (r=.47; p<.05) existed between senior students' Basic Cognitive Abilities score and GEFT score. Similarly, a significant and positive substantial relationship (r=.51; p<.05) existed between senior students' Application Abilities score and GEFT. In addition, a significant and positive moderate relationship
(r=.36; p<.05) existed between students' Critical Thinking score and GEFT.

Table 38

<table>
<thead>
<tr>
<th>Relationship Between Cognitive Abilities and Learning Style (n=103)</th>
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<tbody>
<tr>
<td>Level of Cognition</td>
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<tr>
<td>---------------------------------------------------------------</td>
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<tr>
<td>Basic Cognitive Abilities</td>
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<tr>
<td>Application Abilities</td>
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<tr>
<td>Critical Thinking Abilities</td>
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*Note. Coefficients reported as Pearson Product-Moment Correlations
*p<.05
CHAPTER V
SUMMARY, CONCLUSIONS AND IMPLICATIONS, AND RECOMMENDATIONS

Summary

Purpose of the Study

The purpose of the study was to describe the cognitive abilities and the learning style of students enrolled in the College of Agriculture at The Ohio State University. Furthermore, the study sought to relate cognitive abilities to selected student characteristics, including learning style.

Research Objectives

To achieve the purpose of the study, the following objectives were developed. The objectives were to:

1. Describe senior students in the College of Agriculture at The Ohio State University on the following personalogical variables: age, gender, ACT composite score, cumulative GPA, choice of academic major, and ethnic background.

2. Determine the cognitive abilities (Basic, Application, and Critical Thinking) of senior students enrolled in the College of Agriculture at The Ohio State University as measured by the Developing Cognitive Abilities Test (DCAT), Level L.

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3. Determine the learning style of senior students enrolled in the College of Agriculture at The Ohio State University as measured by the Group Embedded Figure Test (GEFT).

4. Describe the relationships between cognitive abilities (Basic, Application, and Critical Thinking) utilizing the DCAT and selected variables (age, gender, cumulative GPA, ACT composite score, academic major, ethnic background) of senior students enrolled in the College of Agriculture at The Ohio State University.

5. Describe the relationship between learning style utilizing the GEFT and selected variables (age, gender, cumulative GPA, ACT composite score, academic major, ethnic background) of senior students enrolled in the College of Agriculture at The Ohio State University.

6. Describe the relationships between cognitive abilities (Basic, Application, and Critical Thinking) utilizing the DCAT and learning style utilizing the GEFT of senior students enrolled in the College of Agriculture at The Ohio State University.

Research Design

The study was descriptive research. Ary, Jacobs, and Razavieh (1990) indicated that the aim of descriptive research was to describe "what exists" with respect to variables or conditions in a situation. Thus, the study was designed to
obtain information about students concerning cognitive abilities (Basic, Application, and Critical Thinking), learning style, and personalogical variables. Three instruments were utilized to gather the variety of data and information required to present a detailed account of each variable of interest and to accomplish the objectives of the study.

**Population and Sample**

The target population for the study was senior students (N=388) enrolled in the College of Agriculture at The Ohio State University and excluded the School of Natural Resources during Autumn Quarter, 1992. The sample size required to be representative of the population (N=388) (with in a five percent margin of error) was 196. The sample size (n=196) was randomly drawn and proportionally stratified by major.

**Instrumentation and Data Collection**

Two standardized instruments were utilized to obtain data needed to address the objectives of the study. The two instruments were the Developing Cognitive Abilities Test (DCAT), Level L (Beggs & Mouw, 1989), and the Group Embedded Figure Test (Witkin, Oltman, Raskin, & Karp, 1971). In addition, a student personalogical instrument was utilized to gather data from the College Office.
The data collection period encompassed six weeks. Students selected to participate in the study were mailed a letter of invitation strongly encouraging the students to participate in the study. The letter specified four dates with two data collection sessions on each date in which students were invited to attend any one of the eight sessions. The data collection dates were in February, 1993.

The data collection sessions required one hour and thirty minutes each. The researcher administered the data collection instruments at all data collection sessions in accordance to the procedures specified in both the GEFT and DCAT manuals provided by the respective test distributors. All data collection sessions were located in Room 105 of the Agricultural Administration Building.

A total of 47 percent (92) of the sample participated in the eight scheduled and one make-up data collection sessions. Students who did not attend any of the data collection sessions were treated as non-respondents. The process for addressing and controlling non-response error was recommended by Miller and Smith (1983) and included sampling ten percent of the non-respondents.

To determine if non-respondents were similar to respondents, non-respondents were statistically compared to respondents on selected variables. No significant differences (p>.05) were found between the sample of non-respondents and the sample of respondents on the variables of interest.
(learning style and cognitive abilities - Basic, Application, and Critical Thinking), cumulative GPA, and age. Thus, the non-respondent data were pooled with the respondent data; yielding a sample size of 103 and generalized to the sample/population (Miller & Smith, 1983).

**Data Analysis**

Raw data were coded and entered into SPSS/PC+ (Statistical Package for the Social Science, Personal Computer Version) Data Entry to employ statistical applications. Both descriptive and inferential statistics were used to analyze the data. The data were analyzed utilizing the SPSS/PC+ program. Frequency distributions, percentages, means, modes, and standard deviations were generated to address the objectives of the study. Additionally, Pearson product-moment and point-biserial correlation coefficients were calculated to describe relationships between variables. The alpha level was set *a priori* at .05. The magnitude of the relationships were described using Davis' (1971) conventions.

**Summary of Findings**

**Students' Characteristics**

Personalogical data were gathered on 103 senior students enrolled in the College of Agriculture, The Ohio State University, during Autumn Quarter, 1992. Personalogical data included age, gender, academic major, ethnicity, cumulative
GPA, and ACT composite score. The ensuing summary results are a description of the personalogical variables.

The age of senior students ranged from 22 to 41 years of age with a mean age 23.7 years. The majority of the senior students were male (57.3%). Females composed 42.7 percent of the senior students.

It found that the academic major with the largest proportion (26.2%) of students was Animal Science (n=27). The academic majors that followed were: Agricultural Economics (20.4%; n=21); Horticulture (15.5%; n=16); Agricultural Education (10.7%; n=11); Food Science (7.8%; n=8); Dairy Science (6.8%; n=7); Agronomy (6.8%; n=7); Agricultural Communication (3.4%; n=4); and Agricultural Mechanics (1.9%; n=2). In addition, it was found that sample student proportions by academic major appeared to be similar when compared to actual (population) student proportions by academic major.

Three ethnic groups were identified from the 103 senior students. The three ethnic groups were: White, African-American, and Hispanic. It was found that an overwhelming proportion (94.2%) of the senior students were White (n=97). African-Americans made-up 4.8 percent (n=5) of the senior students and only one senior student (1.0%) was Hispanic.

The senior students ranged in cumulative GPA from 1.84 to 3.98 and had a mean cumulative GPA of 2.75. An ACT composite score was only available for 84 (82.0%) of the 103 senior
students. For the 84 students, ACT composite scores ranged from 9 to 31 and had a mean ACT composite score of 21.26.

Students' Cognitive Abilities

The DCAT provided raw scores on the 103 senior students on three levels of cognition (Basic Cognitive Abilities, Application Abilities, Critical Thinking Abilities). The maximum possible score on each of the three levels of cognition was 27.

The mean raw score for senior students on the Basic Cognitive Abilities items was 19.9 with individual raw scores ranging from 8 to 27. The mean raw score for the Application Abilities items was 20.2 with individual raw scores ranging from 12 to 26. The mean raw score for the Critical Thinking Abilities items was 16.2 with individual raw scores ranging from 6 to 26.

Cognitive Abilities by Gender

A gender analysis indicated that male senior students scored a raw mean of 20.2 on Basic Cognitive Abilities items with individual raw scores ranging from 10 to 27. The mean raw score for males on Application Abilities items was 20.9 with individual raw scores ranging from 14 to 26. In addition, the mean raw score for males on Critical Thinking Abilities items was 16.7 with individual raw scores ranging from 6 to 25.
Similarly, female senior students scored a raw mean of 19.4 on Basic Cognitive Abilities items with individual scores ranging from 8 to 26. The mean raw score for females on Application Abilities items was 19.3 with individual raw scores ranging from 12 to 25. In addition, the mean raw score for females on Critical Thinking Abilities items was 16.9 with individual raw scores ranging from 6 to 26.

Cognitive Abilities by Academic Major

Descriptive data (mean and range) were calculated for the nine (9) academic majors on the three levels of cognition (Basic Cognitive Abilities, Application Abilities, Critical Thinking Abilities).

Cognitive Abilities

The raw means for the nine (9) academic majors on the Application Abilities ranged from 19.1 to 22.3. The raw means for the Application Abilities ranged from 17.5 to 22.6. The raw means for the Critical Thinking Abilities ranged from 15.1 to 18.5.

Animal Science

Senior students majoring in Animal Science ranged in raw score from 14 to 25 on Basic Cognitive Abilities and had a mean raw score of 20.4. Similarly, individual raw scores for senior students majoring in Animal Science ranged from 15 to 25 on Application Abilities and had a mean raw score of 19.7. In addition, senior students majoring in Animal Science ranged
in raw score from 6 to 25 on Critical Thinking Abilities and had a mean raw score of 17.4.

**Agricultural Economics**

Senior students majoring in Agricultural Economics ranged in raw score from 13 to 25 on Basic Cognitive Abilities and had a mean raw score of 19.1. Similarly, individual raw scores for senior students majoring in Agricultural Economics ranged in raw score from 12 to 26 on Application Abilities and had a mean raw score of 19.6. In addition, senior students majoring in Agricultural Economics ranged in raw score from 6 to 23 on Application Abilities and had a mean raw score of 16.6.

**Horticulture**

Senior students majoring in Horticulture ranged in raw score from 12 to 24 on Basic Cognitive Abilities with a mean raw score of 18.3. Senior students majoring in Horticulture ranged on raw score from 17 to 25 on Application Abilities and had a mean raw score of 19.9. In addition, senior students majoring in Horticulture ranged in raw score from 1 to 26 on Critical Thinking Abilities and had a mean raw score of 16.1.

**Agricultural Education**

Senior students majoring in Agricultural Education ranged in raw score from 17 to 23 on Basic Cognitive Abilities with a mean raw score of 20.6. Similarly, senior students majoring in Agricultural Education ranged in raw score from 19 to 25 on Application Abilities and had a mean raw score of 22.6. In
addition, senior students majoring in Agricultural Education ranged in raw score from 13 to 22 on Critical Thinking Abilities and had a mean raw score of 18.3.

**Food Science**

Senior students majoring in Food Science ranged in raw score from 10 to 26 on Basic Cognitive Abilities with a mean raw score of 20.4. Similarly, senior students majoring in Food Science ranged in raw score from 14 to 25 on Application Abilities and had a mean raw score of 20.8. In addition, senior students majoring in Food Science ranged in raw score from 6 to 25 on Critical Thinking Abilities and had a mean raw score of 16.4.

**Dairy Science**

Senior students majoring in Dairy Science ranged in raw score from 20 to 27 on Basic Cognitive Abilities with a mean raw score of 22.3. Similarly, senior students majoring in Dairy Science ranged in raw score from 17 to 24 on Application Abilities and had a mean raw score of 21.3. In addition, senior students majoring in Dairy Science ranged in raw score from 12 to 21 on Critical Thinking Abilities and had a mean raw score of 16.4.

**Agronomy**

Senior students majoring in Agronomy ranged in raw score from 16 to 26 on Basic Cognitive Abilities with a mean raw score of 19.4. Similarly, senior students majoring in Agronomy ranged in raw score from 16 to 23 on Application
Abilities and had a mean raw score of 20.6. In addition, senior students majoring in Agronomy ranged in raw score from 9 to 19 on Critical Thinking Abilities and had a mean raw score of 15.1.

**Agricultural Communication**

Senior students majoring in Agricultural Communication ranged in raw score from 8 to 26 on Basic Cognitive Abilities with a mean raw score of 19.3. Senior students majoring in Agricultural Communication ranged in raw score from 13 to 21 on Application Abilities and had a mean raw score of 17.5. In addition, senior students majoring in Agricultural Communication ranged in raw score from 13 to 22 on Critical Thinking Abilities and had a mean raw score of 16.3.

**Agricultural Mechanics**

Senior students majoring in Agricultural Mechanics ranged in raw from 21 to 22 on Basic Cognitive Abilities with a mean raw score of 21.5. Similarly, senior students majoring in Agricultural Mechanics ranged in raw score from 19 to 23 on Application Abilities and had a mean raw score of 21.0. In addition, senior students majoring in Agricultural Mechanics ranged in raw score from 18 to 19 on Critical Thinking Abilities and had a mean raw score of 18.5.
Students' Learning Style

The preferred learning style of senior students were dichotomized as either field dependent or field independent. An analysis of the GEFT scores indicated that 38.8 percent of the senior students leaned toward a field dependent learning style. Conversely, 61.2 percent of the senior students leaned toward the field independent learning style. The mean raw GEFT score for senior students was 12.4. The raw GEFT scores for senior students ranged from 1 to the maximum possible score of 18.

Learning Style by Gender

A gender analysis indicated that 28.8 percent of the male senior students leaned toward the field dependent learning style while a majority (71.2%) of the male senior students leaned toward a field independent learning style. Approximately 50 percent of the female senior students leaned toward the field dependent learning and approximately 50 percent toward the field independent learning style.

The raw GEFT scores ranged from 1 to 18 for male senior students and had a mean GEFT score of 13.4. Female senior students ranged in raw GEFT scores from 2 to 18 and had a mean raw GEFT score of 11.1.

Learning Style by Academic Major

The raw mean scores for the nine (9) academic majors on the GEFT ranged from 8.5 to 15.6. The percent of field
dependent learning style and field independent learning style, and mean GEFT score for each academic major follows.

**Animal Science**

Of the senior students majoring in Animal Science, 29.4 percent leaned toward the field dependent learning style and 70.4 percent leaned toward the field independent learning style. The raw GEFT scores for students majoring in Animal Science ranged from 2 to 18 and had a mean raw GEFT score of 13.1.

**Agricultural Economics**

Of the senior students majoring in Agricultural Economics, 52.4 percent leaned toward the field dependent learning style and 47.6 percent leaned toward the field independent learning style. The raw GEFT scores for students majoring in Agricultural Economics ranged from 4 to 18 and had a mean raw GEFT score of 11.1.

**Horticulture**

Of the senior students majoring in Horticulture, 43.8 percent leaned toward the field dependent learning style and 56.2 percent leaned toward the field independent learning style. The raw GEFT scores for students majoring in Horticulture ranged from 3 to 18 and had a mean raw GEFT score of 12.1.

**Agricultural Education**

Of the senior students majoring in Agricultural Education, 9.1 percent leaned toward the field dependent
learning style and 90.1 percent leaned toward the field independent learning style. The raw GEFT scores for students majoring in Agricultural Education ranged from 9 to 18 and had a mean raw GEFT score of 15.6.

Food Science

Of the senior students majoring in Food Science, 37.5 percent leaned toward the field dependent learning style and 62.5 percent leaned toward the field independent learning style. The raw GEFT scores for students majoring in Food Science ranged from 1 to 17 and had a mean raw GEFT score of 11.3.

Dairy Science

Of the senior students majoring in Dairy Science, 14.3 percent leaned toward the field dependent learning style and 85.7 percent leaned toward the field independent learning style. The raw GEFT scores for students majoring in Dairy Science ranged from 11 to 17 and had a mean raw GEFT score of 13.7.

Agronomy

Of the senior students majoring in Agronomy, 71.4 percent leaned toward the field dependent learning style and 28.6 percent leaned toward the field independent learning style. The raw GEFT scores for students majoring in Agronomy ranged from 10 to 17 and had a mean raw GEFT score of 12.3.
Agricultural Communication

Of the senior students majoring in Agricultural Communication, 75.0 percent leaned toward the field dependent learning style and 25.0 percent leaned toward the field independent learning style. The raw GEFT scores for students majoring in Agricultural Communication ranged from 2 to 15 and had a mean raw GEFT score of 8.8.

Agricultural Mechanics

Of the senior students majoring in Agricultural Mechanics, 50.0 percent leaned toward the field dependent learning style and 50.0 percent leaned toward the field independent learning style. The raw GEFT scores for students majoring in Agricultural Mechanics ranged from 8 to 13 and had a mean raw GEFT score of 10.5.

Correlates of Students' Cognitive Abilities

Basic Cognitive Abilities

The correlation coefficients were calculated between senior students' Basic Cognitive Abilities score and their characteristics (age, gender, cumulative GPA, ACT composite score). The relationship between the senior students' age and Basic Cognitive Abilities score was positive, but negligible ($r = .03$). The relationship between senior students' gender and Basic Cognitive Abilities score was positive, but negligible ($r_p = .10$). There was a significant and substantial positive relationship ($r = .53; \ p < .05$) between senior students'
cumulative GPA and Basic Cognitive Abilities score. In addition, there was a significant and substantial positive relationship \((r = .54; \ p < .05)\) between senior students' ACT composite score and Basic Cognitive Abilities score.

A multiple coefficient of correlation (Multiple R) was calculated for students' Basic Cognitive Abilities score and senior students' characteristics (age, gender, cumulative GPA) \((R = .55)\) and was interpreted as a positive substantial correlation between senior students' predicted Basic Cognitive Abilities score (derived from students' characteristics) and the observed Basic Cognitive Abilities score. It was found that students' characteristics explained 31 percent of the variance in Basic Cognitive Abilities score \((F = 14.76; \ p < .05)\).

**Application Abilities**

The correlation coefficients were calculated between senior students' Application Abilities score and their characteristics (age, gender, cumulative GPA, ACT composite score). The relationship between the senior students' age and Application Abilities score was negative, but negligible \((r = -.02)\). Similarly, a significant and positive low relationship \((r_p = .25; \ p < .05)\) existed between senior students' gender and Application Abilities score. Likewise, there was a significant and moderate positive relationship \((r = .49; \ p < .05)\) between senior students' cumulative GPA and Application Abilities score. In addition, there was a significant and
moderate positive relationship \((r=.46; p<.05)\) between senior students' ACT composite score and Application Abilities score.

A multiple coefficient of correlation (Multiple R) was calculated for students' Application Abilities score and senior students' characteristics (age, gender, cumulative GPA) \((R=.54)\) and was interpreted as a positive substantial correlation between senior students' predicted Application Abilities score (derived from students' characteristics) and the observed Application Abilities score. It was found that students' characteristics explained 29 percent of the variance in Application Abilities score \((F=13.23; p<.05)\).

Critical Thinking Abilities

The correlation coefficients were calculated between senior students' Critical Thinking Abilities score and their characteristics (age, gender, cumulative GPA, ACT composite score). The relationship between the senior students' age and Critical Thinking Abilities score was negative, but negligible \((r=-.08)\). A negative negligible relationship \((r_{pb}=-.02)\) existed between senior students' gender and Critical Thinking Abilities score. There was a significant and moderate positive relationship \((r=.33; p<.05)\) between senior students' cumulative GPA and Critical Thinking Abilities score. Likewise, there was a significant and moderate positive relationship \((r=.40; p<.05)\) between senior students' ACT composite score and Critical Thinking Abilities score.
A multiple coefficient of correlation (Multiple R) was calculated for students' Critical Thinking Abilities score and senior students' characteristics (age, gender, cumulative GPA) (R=.35) and was interpreted as a positive moderate correlation between senior students' predicted Critical Thinking Abilities score (derived from students' characteristics) and the observed Critical Thinking Abilities score. It was found that students' characteristics explained 12 percent of the variance in Critical Thinking Abilities score (F=4.71; p<.05).

**Academic Major**

**Basic Cognitive Abilities**

Point-biserial correlation coefficients were used to describe the relationship between Basic Cognitive Abilities score and the nine (9) academic majors. The relationship between Basic Cognitive Abilities score and senior students majoring in Animal Science (n=27) was positive, but negligible ($r_{pb}=.09$). A negative low relationship ($r_{pb}=-.11$) existed between Basic Cognitive Abilities score and students majoring in Agricultural Economics (n=21). Similarly, a negative low relationship ($r_{pb}=-.18$) existed between Basic Cognitive Abilities score and students majoring in Horticulture (n=16). A positive, but negligible relationship ($r_{pb}=.07$) existed between Basic Cognitive Abilities score and students majoring in Agricultural Education (n=11).
A positive negligible relationship ($r_{pb} = .04$) existed between Basic Cognitive Abilities score and students majoring in Food Science ($n=8$). A positive low relationship ($r_{pb} = .18$) existed between Basic Cognitive Abilities score and students majoring in Dairy Science ($n=7$). A negative negligible relationship ($r_{pb} = -.03$) existed between Basic Cognitive Abilities score and students majoring in Agronomy ($n=7$). Similarly, a negative negligible relationship ($r_{pb} = -.03$) existed between Basic Cognitive Abilities score and students majoring in Agricultural Communication ($n=4$). A positive negligible relationship ($r_{pb} = .06$) existed between Basic cognitive Abilities score and students majoring in Agricultural Mechanics ($n=2$). None of the point-biserial correlation coefficients calculated to describe the relationship between students Basic Cognitive Abilities score and academic major were significant ($p < .05$).

A multiple coefficient of correlation (Multiple R) was calculated for students' Basic Cognitive Abilities score and academic major ($R = .29$) and was interpreted as a positive low correlation between senior students' predicted Basic Cognitive Abilities score (derived from academic major) and the observed Basic Cognitive Abilities score. It was found that academic major explained eight percent of the variance in Basic Cognitive Abilities score ($F = 1.09; p > .05$).
Application Abilities

Point-biserial correlation coefficients were used to describe the relationship between Application Abilities score and academic major. The relationship between Application Abilities score and senior students majoring in Animal Science (n=27) was negative and low ($r_{pb}=-.10$). A negative low relationship ($r_{pb}=-.10$) existed between Application Abilities score and students majoring in Agricultural Economics (n=21). Similarly, a negative negligible relationship ($r_{pb}=-.03$) existed between Application Abilities score and students majoring in Horticulture (n=16). A significant and positive low relationship ($r_{pb}=.25$; $p<.05$) existed between Application Abilities score and students majoring in Agricultural Education (n=11).

A positive negligible relationship ($r_{pb}=.05$) existed between Application Abilities score and students majoring in Food Science (n=8). A positive negligible relationship ($r_{pb}=.09$) existed between Application Abilities score and students majoring in Dairy Science (n=7). A positive negligible relationship ($r_{pb}=.03$) existed between Application Abilities score and students majoring in Agronomy (n=7). In addition, a negative low relationship ($r_{pb}=-.17$) existed between Application Abilities score and students majoring in Agricultural Communication (n=4). A positive negligible relationship ($r_{pb}=.04$) existed between Application Abilities score and students majoring in Agricultural Mechanics (n=2).
With the exception of Agricultural Education, none of the point-biserial correlation coefficients calculated to describe the relationship between students Application Abilities score and academic major were significant (p<.05).

A multiple coefficient of correlation (Multiple R) was calculated for students' Application Abilities score and academic major (R=.34) and was interpreted as positive moderate correlation between senior students' predicted Application Abilities score (derived from academic major) and the observed Application Abilities score. It was found that academic major explained 12 percent of the variance in Application Abilities score (F=1.53; p>.05).

**Critical Thinking Abilities**

Point-biserial correlation coefficients were used to describe the relationship between Critical Thinking Abilities score and academic major. The relationship between Critical Thinking Abilities score and senior students majoring in Animal Science (n=27) was positive, but negligible ($r_{pb}=.09$). A negative negligible relationship ($r_{pb}=-.02$) existed between Critical Thinking Abilities score and students majoring in Agricultural Economics (n=21). Similarly, a negative negligible relationship ($r_{pb}=-.08$) existed between Critical Thinking Abilities score and students majoring in Horticulture (n=16). A positive low relationship ($r_{pb}=.12$) existed between Critical Thinking Abilities score and students majoring in Agricultural Education (n=11).
A negative negligible relationship ($r_{pb} = -.03$) existed between Critical Thinking Abilities score and students majoring in Food Science ($n=8$). A negative negligible relationship ($r_{pb} = -.02$) existed between Critical Thinking Abilities score and students majoring in Dairy Science ($n=7$). A negative low relationship ($r_{pb} = -.11$) existed between Critical Thinking Abilities score and students majoring in Agronomy ($n=7$). In addition, a negative negligible relationship ($r_{pb} = -.03$) existed between Critical Thinking Abilities score and students majoring in Agricultural Communication ($n=4$). A positive negligible relationship ($r_{pb} = .06$) existed between Critical Thinking Abilities score and students majoring in Agricultural Mechanics ($n=2$). None of the point-biserial correlation coefficients calculated to describe the relationship between students Critical Thinking Abilities score and academic major were significant ($p < .05$).

A multiple coefficient of correlation (Multiple $R$) was calculated for students' Critical Thinking Abilities score and academic major ($R = .21$) and was interpreted as positive low correlation between senior students' predicted Critical Thinking Abilities score (derived from academic major) and the observed Critical Thinking Abilities score. It was found that academic major explained four percent of the variance in Critical Thinking Abilities score ($F = .55; p > .05$).
Correlates of Students' Learning Style

Students' Characteristics

Correlations coefficients were calculated to describe the relationship between senior students' preferred learning style as measured by the GEFT and interval variables: age, cumulative GPA, and ACT composite score. The relationship between the senior students' age and GEFT score was negative and low ($r = -.19$). A significant and low positive relationship ($r_{pb} = .26; p < .05$) existed between senior students' gender and GEFT score. Additionally, there was a significant and moderate positive relationship ($r = .34; p < .05$) between senior students' cumulative GPA and GEFT score. Furthermore, there was a significant and moderate positive relationship ($r = .34; p < .05$) between senior students' ACT composite score and GEFT score.

A multiple coefficient of correlation (Multiple R) was calculated for students' GEFT score and senior students' characteristics (age, gender, cumulative GPA) ($R = .36$) and was interpreted as a positive moderate correlation between senior students' predicted GEFT score (derived from students' characteristics) and the observed GEFT score. It was found that students' characteristics explained 13 percent of the variance in GEFT score ($F = 5.02; p < .05$).

Academic Major

Point-biserial correlation coefficients ($r_{pb}$) were calculated to describe the relationship between senior
students' GEFT score and each of the nine (9) academic majors. The relationship between GEFT score and senior students majoring in Animal Science (n=27) was positive, but negligible ($r_{pb} = .09$). A negative low relationship ($r_{pb} = -.16$) existed between GEFT score and students majoring in Agricultural Economics (n=21). Similarly, a negative negligible relationship ($r_{pb} = -.03$) existed between GEFT score and students majoring in Horticulture (n=16). A positive low relationship ($r_{pb} = .25$) existed between GEFT score and students majoring in Agricultural Education (n=11).

A negative negligible relationship ($r_{pb} = -.08$) existed between GEFT score and students majoring in Food Science (n=8). A positive negligible relationship ($r_{pb} = .08$) existed between GEFT score and students majoring in Dairy Science (n=7). A negative negligible relationship ($r_{pb} = -.01$) existed between Basic Cognitive Abilities score and students majoring in Agronomy (n=7). Similarly, a negative low relationship ($r_{pb} = -.17$) existed between GEFT score and students majoring in Agricultural Communication (n=4). A negative negligible relationship ($r_{pb} = -.06$) existed between GEFT score and students majoring in Agricultural Mechanics (n=2). None of the point-biserial correlation coefficients calculated to describe the relationship between students' GEFT score and academic major were significant (p<.05).

A multiple coefficient of correlation (Multiple R) was calculated for students' GEFT score and academic major (R=.37)
and was interpreted as positive moderate correlation coefficient between senior students' predicted GEFT score (derived from academic major) and the observed GEFT score. It was found that academic major explained 13 percent of the variance in GEFT score (F=1.83; p>.05).

Relationship Between Cognitive Abilities and Learning Style of Students

Pearson product-moment correlation coefficients (r) were computed to describe the relationship between cognitive abilities (Basic Cognitive Abilities, Application Abilities, Critical Thinking Abilities) and GEFT score. A significant and positive moderate relationship (r=.47; p<.05) existed between senior students' Basic Cognitive Abilities score and GEFT score. Similarly, a significant and positive substantial relationship (r=.51; p<.05) existed between senior students' Application Abilities score and GEFT score. In addition, a significant and positive moderate relationship (r=.36; p<.05) existed between students' Critical Thinking score and GEFT score.

Conclusions and Implications

Based upon the interpretation of the results of the study, the following conclusions and implications were drawn.

Conclusion 1. Senior students enrolled in the College of Agriculture scored highest on Application Abilities items as
measured by the DCAT when compared to Basic Cognitive Abilities items and Critical Thinking Abilities items. Moreover, senior students enrolled in the College of Agriculture scored lowest on Critical Thinking Abilities items as measured by the DCAT when compared to Basic Cognitive Abilities items and Application Abilities items.

Beggs and Mouw (1989) indicated that DCAT results can be used to identify students' strengths, weaknesses, and abilities that can be developed through instructional intervention. Converting the raw mean score on Basic Cognitive Abilities items into percentage, senior students enrolled in the College of Agriculture scored an average of 73.7 percent on Basic Cognitive Abilities items as measured by the DCAT.

Converting the raw mean score on Application Abilities items into percentage, senior students enrolled in the College of Agriculture scored an average of 74.8 percent on Application Abilities items as measured by the DCAT. In addition, by converting the raw mean score on Critical Thinking Abilities items into percentage, senior students enrolled in the College of Agriculture scored an average of 62.2 percent on Critical Thinking Abilities items as measured by the DCAT.

Implication 1. While senior students enrolled in the College of Agriculture did well on Basic Cognitive Abilities, achieving an average score of 73.7 percent would imply that
senior students, as a whole, have the capacity for improvement on Basic Cognitive Abilities through instructional intervention which includes abilities in the recall/knowledge and comprehension levels of cognition. Similarly, achieving an average score of 74.8 percent would imply that senior students enrolled in the College of Agriculture, as a whole, have the capacity for improvement on Application Abilities through instructional intervention which includes abilities in the application level of cognition. However, achieving an average score of 62.2 percent would imply the senior students enrolled in the College of Agriculture, as a whole, have the greatest need for cognitive development on Critical Thinking Abilities through instructional intervention which includes abilities in the analysis and synthesis levels of cognition.

Conclusion 2. Gender ability differences were present in senior students enrolled in the College of Agriculture in the range of cognitive levels (knowledge, comprehension, application, analysis, synthesis), however, no practical difference appeared to exist. Converting raw scores into percentages, male senior students enrolled in the College of Agriculture scored an average of 74.8 percent on Basic Cognitive Abilities items as measured by the DCAT. Female senior students enrolled in the College of Agriculture scored an average of 71.9 percent on the Basic Cognitive Abilities item as measured by the DCAT.
Similarly, male senior students enrolled in the College of Agriculture scored an average of 77.4 percent on Application Abilities items as measured by the DCAT. Conversely, female senior students enrolled in the College of Agriculture scored an average of 71.5 percent on Application Abilities items as measured by the DCAT. In addition, male senior students enrolled in the College of Agriculture scored an average of 61.9 percent on Critical Thinking Abilities items as measured by the DCAT, where female senior students scored an average of 62.6 percent.

**Implication 2.** The data suggested that no practical difference existed in cognitive ability of senior students enrolled in the College of Agriculture by gender. The lack of practical differences by gender of senior students enrolled in the College of Agriculture in cognitive ability as measured by the DCAT would imply that the cognitive development in male and female senior students was similar.

However, the differences that did exist suggested that male senior students enrolled in the College of Agriculture tended to score higher than female senior students enrolled in the College of Agriculture on the basic recall/knowledge of facts, general comprehension ideas and application items. Whereas female senior students enrolled in the College of Agriculture tended to do better than male senior students enrolled in the College of Agriculture on abilities related to analysis and synthesis.
Conclusion 3. Senior students enrolled in the College of Agriculture tended to prefer a field independent learning style. The mean raw Group Embedded Figures Test (GEFT) score for senior students enrolled in the College of Agriculture was 12.4 out of a maximum possible score of 18. Witkin et al., (1977b) reported a mean GEFT score of 11.6 for college graduates.

Individuals scoring greater than the national mean (11.4) on the GEFT were considered to be leaning toward the field independent learning style. Conversely, senior students scoring less than the national mean are considered to be leaning toward the field dependent learning style (Witkin et al., 1971).

Implication 3. A raw mean GEFT score of 12.4 would imply that senior students enrolled in the College of Agriculture have a field independent learning style. However, the variance (standard deviation=4.27) reported in the findings suggested that the majority (68%) of the individual GEFT scores ranged from 8 to 17. The range of GEFT scores (8-17) indicated that the majority (68%) of the senior students enrolled in the College of Agriculture range from a marginal field dependent learning style to a more dominant field independent learning style.

Conclusion 4. Of the senior students enrolled in the College of Agriculture, males preferred a field independent learning style, whereas females preferred a more field dependent
learning style. Persistent gender differences have been found in the field dependence/independence dimension by several researchers (Garger & Guild, 1984; Witkin, 1976; Claxton & Ralston; Reiff, 1992) and is supported by the current study. Implication 4. With a preference for a field independent learning style, male senior students in the College of Agriculture, as a group, tend to view the world more analytically, find it easier to solve problems, and are more likely to favor "inquiry" and independent study. When compared with female senior students enrolled in the College of Agriculture, male senior students tend to provide their own structure to facilitate learning, are more intrinsically motivated, and are generally unresponsive to social reinforcement.

Conversely, female senior students enrolled in the College of Agriculture, as a group, prefer a field dependent learning style and tend to perceive the world globally. In addition, female senior students find it more difficult to solve problems, are highly sensitive and attuned to the social environment, tend to favor the "spectator approach" to learning, and will adopt the organization of information to be learned. Additionally, female senior students are more extrinsically motivated and responsive to social reinforcement than males.

Conclusion 5. Of the characteristics studied (age, gender, cumulative GPA, ACT composite score) of senior students
enrolled in College of Agriculture, cumulative GPA was the only variable that was a predictor of Basic Cognitive Abilities score as measured by the DCAT. Confined only to senior students in the study whose ACT composite score were available, ACT composite score was a predictor of Basic Cognitive Abilities score as measured by the DCAT.

Pascarella (1985) and Halpern (1986) indicated that student attributes such as age and gender should be considered as potential variables that influence cognitive ability. However, the current study does not support Pascarella's (1985) nor Halpern's (1986) claim as the data of the current study suggests that age and gender are not suitable predictors of Basic Cognitive Abilities score as measured by the DCAT.

Implication 5. The data imply that cumulative GPA is a significant predictor of performance on general recall/knowledge and comprehension items for senior students enrolled in the College of Agriculture. Thus, senior students having a high cumulative GPA tended to do well on items requiring abilities in knowledge and comprehension. Furthermore, ACT composite score was a good predictor of abilities in basic knowledge and comprehension for senior students whose ACT composite score were available in the study.

Conclusion 6. Of the characteristics studied (age, gender, cumulative GPA, ACT composite score) of senior students enrolled in College of Agriculture, gender and cumulative GPA were the only variables that were predictors of Application
Abilities score as measured by the DCAT. Confined only to the
senior students in the study whose ACT composite score were
available, ACT composite score was a predictor of Application
Abilities score as measured by the DCAT.

Implication 6. The data imply that gender and cumulative GPA
are significant predictors of application abilities for senior
students enrolled in the College of Agriculture. Thus, male
senior students enrolled in the College of Agriculture have
better developed application abilities than do female senior
students enrolled in the College of Agriculture. Additionally, senior students enrolled in the College of
Agriculture having a high cumulative GPA will tend to do well
on application abilities. Furthermore, senior students in the
study whose ACT composite score were available, those who had
a high ACT composite score tended to do well on abilities
requiring application.

Conclusion 7. Of the characteristics studied (age, gender,
cumulative GPA, ACT composite score) of senior students
enrolled in College of Agriculture, cumulative GPA was the
only variable that was a predictor of Critical Thinking score
as measured by the DCAT. For senior students in the study
whose ACT composite score were available, ACT composite score
was a predictor of Critical Thinking Abilities score as
measured by the DCAT.

Implication 7. The data imply that cumulative GPA is a
significant predictor of analysis and synthesis abilities for
senior students enrolled in the College of Agriculture. Thus, senior students enrolled in the College of Agriculture having a high cumulative GPA will tend to perform well on analysis and synthesis tasks. Furthermore, for senior students in the study whose ACT composite score were available, those who had a high ACT composite score tended to do well on analysis and synthesis abilities.

**Conclusion 8.** Academic major was not a good predictor of Basic Cognitive Abilities, Application Abilities, or Critical Thinking Abilities score as measured by the DCAT of senior students enrolled in the College of Agriculture.

**Implication 8.** Academic major is not a good predictor of general abilities in recall/knowledge, comprehension, application, analysis, or synthesis levels of cognition for senior students enrolled in the College of Agriculture.

**Conclusion 9.** Of the characteristics studied (age, gender, cumulative GPA, ACT composite score) of senior students enrolled in College of Agriculture, gender and cumulative GPA were the only variables that were predictors of learning style as measured by GEFT score. Witkin et al. (1977b) claimed that GEFT scores showed little association to cumulative GPA, however the current study demonstrated a moderate relationship. For senior students in the study whose ACT composite score were available, ACT composite score was a predictor of learning style as measured by the GEFT.
Implication 9. The data imply that for senior students enrolled in the College of Agriculture, gender and cumulative GPA are suitable predictors of learning style as measured by the GEFT. Moreover, male senior students enrolled in the College of Agriculture tended to prefer a field independent learning style. Similarly, senior students enrolled in the College of Agriculture who tended to prefer a field independent learning style had a high cumulative GPA. Furthermore, for senior students who participated in the study and whose ACT composite score were available, those who had a high ACT composite score tended to prefer a field independent learning style.

Conclusion 10. Academic major was not a good predictor of learning style as measured by the GEFT score of senior students enrolled in the College of Agriculture.

Implication 10. Academic major is not a good predictor of learning style of senior students enrolled in the College of Agriculture.

Conclusion 11. Senior students enrolled in the College of Agriculture who preferred a field independent learning style tended to perform better on the three levels of cognition (Basic Cognitive Abilities, Application Abilities, Critical Thinking Abilities) as measured by the DCAT.

Implication 11. Senior students enrolled in the College of Agriculture who preferred a field independent learning style tended to perform better on the range of cognitive levels
(knowledge, comprehension, application, analysis, and synthesis).

Recommendations

Recommendations for Instruction

1. Instructional intervention should occur to strengthen cognitive development at all levels of cognition (knowledge, comprehension, application, analysis, synthesis) of senior students enrolled in the College of Agriculture. In particular, senior students enrolled in the College of Agriculture require development in the upper levels of cognition (analysis and synthesis). Instructors should place greater emphasis upon instruction requiring abilities in analysis and synthesis in classroom discourse and examinations or quizzes, and out-of-class assignments and activities.

2. Classroom discourse of instructors should invoke active student involvement to stimulate student thinking at the higher levels of cognition. Instructors should consider the nature of questions utilized during classroom discourse. Instructors should begin discussion by asking recall questions to assess students' knowledge of facts and then ask higher cognitive questions requiring abilities beyond the recall of facts. Gall (1970) suggested that follow-up questions of students' response had a great impact on student cognitive development.
3. Tests and assignments presented by instructors should include tasks requiring students to apply abilities in the upper levels of cognition. Miller (1989) and Pickford (1988) found a positive association between the cognitive level of tests and assignments and level of cognitive performance in college students. Additionally, Newcomb and Trefz (1987) and Miller (1989) supported the notion that when instructors incorporated laboratories, homework, individual group projects, and term papers in the learning process, students were more likely to require use of cognitive abilities in application, analysis, synthesis and evaluation than were tests, quizzes, or in-class discourse.

4. Instructors should be provided with workshops on utilizing the levels of cognition for teaching and learning. The workshops should be designed and implemented with the guidance of the College of Agriculture Teaching Committee. Studies (Clegg, Farley, & Curran, 1967; Farley & Clegg, 1969) have found that instructors asked significantly more questions at higher cognitive levels when they had received instruction in the knowledge and use of Bloom's taxonomy to guide classroom instruction. Additionally, Taba (1966) reported that teachers taught to use Bloom's taxonomy, increased the number of higher levels of interaction,
produced a greater number of ideas, and had ideas or units of thought that were greater in complexity.

5. Because learning style affects the learning success of students in specific kinds of situations, instructors should be sensitive to these learning styles differences. Students' learning style should be used to direct instructors to incorporate various teaching methods (discussion, role play, supervised study, lecture, case study, demonstrations, field trips, resource people, experiments), curriculum materials (textbooks, handouts, worksheets), and evaluation (multiple choice, case studies, essays) techniques into classroom discourse to reach students of differing learning styles.

However, the recommendation does not imply that students be allowed to use learning style as a crutch to avoid completing the assignment. Rather, instructors should attempt to accommodate students' learning style by explaining new concepts several different ways such as providing examples and/or using analogies. Instructors should also attempt to accommodate students' learning style by providing students several options for demonstrating mastery. The key to utilizing information on students' learning style is to teach information through students' learning style but, also help students "stretch" by learning through other learning styles. Instructors should conceive learning style as referring
to actions of the student rather than ability of the student.

6. Instructors should have knowledge of students' preferred learning style. Workshops should be offered to instructors on identifying student learning styles. The workshops should be designed and implemented with the guidance of the College of Agriculture Teaching Committee. Knowledge of field dependence/independence among students should contribute to the instructor's ability to utilize their own teaching style strengths, appreciate the learning style differences of students, and develop diverse strategies to facilitate success and learning.

7. Students should have knowledge of their preferred learning style. As entering college freshmen, students should be assessed for their preferred learning style and discussion should occur on how to use their learning style to their advantage. As a result, students will gain confidence in their learning strengths and develop diverse strategies for handling the challenging situations that are certain to rise. Students will also begin to see how they learn most effectively and efficiently, thus allowing them to be better able to take responsibility for their own learning. In addition, students will learn that their way of learning is not better or worse than those of their peers.
8. It is important for students and instructors to accept and value the diversity of learning styles. Beginning as entering college freshmen, students should be counseled on learning/teaching style differences and begin work on coping with these conflicts. Understanding differences in learning and teaching style should enable students to allow for these differences and improve learning.

9. Administration leaders, such as the Dean, Associate Dean, and Department Chairs, should have knowledge of the differences in learning style. Workshops on learning styles should be offered to college administrators. The workshops should be designed and implemented with the guidance of the College of Agriculture Teaching Committee. Knowledge about learning styles will allow administrative leaders to be more insightful about utilizing faculty/staff members in ways that will be conducive to building on students' greatest strengths and addressing their weaknesses. Additionally, the use of information about learning styles will remind administrative leaders that the institution is seriously interested in the development of students; a purpose that needs to be embraced by instructors and administrators.

10. Academic advisors and college counselors should become knowledgeable about learning styles. Workshops should be offered to academic advisors and college counselors on learning styles. The workshops should be designed and
implemented with the guidance of the College of Agriculture Teaching Committee. Knowledge about learning styles will allow academic advisors to diagnose students' preference for utilizing media, teaching methods, and curriculum materials which will capitalize on their strengths to augment their weaknesses and ensure success in courses and coursework. For example, knowing that field dependent students respond more to external motivation (grades, praise, criticism) than field independent students, academic advisors should question the current practice of placing marginal students in courses which are non-evaluative (pass/fail) in nature. The field dependent student could be ill-served by taking pass/fail courses.

Additionally, knowledge of learning styles has great potential as a tool to aid students in career planning. For example, as suggested by the current study, students with a field dependent learning style are more likely to show interest in Agricultural Communication. Conversely, students with a field independent learning style are more likely to show interest in Animal Science and Dairy Science.

Recommendation for Further Research

1. Students entering college as freshmen should be assessed for their cognitive ability and then again as graduating
senior students to determine individual gains and gains by academic major.

2. A representative sample of students for each academic major in the College of Agriculture should be drawn to assess students' cognitive ability by major.

3. Research should investigate if field independent students in the College of Agriculture have a higher academic achievement as measured by cumulative GPA as a result of instructors classroom discourse.

4. Research should investigate if an instructor's learning style is related to students' cognitive level of performance.

5. Research should investigate if an instructor's learning style is related to the level of cognitive classroom discourse.

6. The learning style of instructors and their students should be assessed to determine if the greater the match between the instructors' learning style and the students' learning style, the greater the student's academic achievement.

7. A representative sample of students for each academic major in the College of Agriculture should be drawn to assess students' learning style by major.

8. Research should investigate if students taught in their preferred learning style score higher on tests,
assignments, and attitude than those taught in a manner dissonant from their orientation.

9. The current study should be replicated in other colleges at The Ohio State University.

10. The current study should be replicated in other colleges of agriculture outside of The Ohio State University.
APPENDIX A

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

I. KNOWLEDGE LEVEL

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

1. Knowledge of Specifics - the recall of specific, separate bits of information. This type of question 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 utilize the concept; only requires an awareness of the concept.
   a. Knowledge of conventions - awareness of accepted ways 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 student's 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 it exists. Example: "What were the events that led up to World War II?"

c. Knowledge of classifications and categories - emphasis is placed upon the students remembering certain groupings 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. Identification or listing of criteria is requested; not an understanding of the basis for establishment of criteria. Example: "Name
three criteria for judging the quality of a

cut of meat."

e. Knowledge of methodology - this dimension
is only concerned with the student's awareness
of several methods or processes, not his/her
ability to apply them to 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 class.
(4) Get permission from the principal.

f. Knowledge of the universals and
abstractions in a field - deals with
knowledge of principles and generalizations
and knowledge of 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?"

INTELLECTUAL SKILLS AND ABILITIES

Refers to the organized modes of operation and generalized
techniques for handling and dealing with materials and problems. The abilities and skills objectives emphasize the mental processes of organizing and reorganizing material to achieve a particular purpose.

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 sublevels (Hunkins, 1972).

1. Translation - focuses on the student's ability to translate or paraphrase information from one to another. 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 a foreign language into English.
   c. translation of material from technical terms into layman's terms.

2. Interpretation - the emphasis is on grasping the basic ideas or general meaning of the material.
   a. The learner must be able to translate each
Comprehension Level (continued)

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. Education should be preparation for life. 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
Application Level (continued)

transferable to many situations.

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

3. They include a minimum of directions or instructions; part of the challenge lies in the student being able to determine the appropriate problem-solving process to use.

C. Evidence shows that once the ability to make application 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 a further step in the "comprehension" of 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, it is very important to use where deeper understanding is required before decisions are reached and problems are attacked (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 judgement (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 - differentiate between various relationships among the elements and determine 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 a 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 student (Chamberlain and Kelly, 1981).

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 particular problem theories or methods.

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 product that produces ideas, feelings, and experiences that are uniquely his/hers; the interpretation should represent the student's individual thinking and personality.

2. Production of a Plan - requires the student to produce a plan or solution to 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
Synthesis Level (continued)

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 forming 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 makes the point that evaluation is not an
activity done after all the other levels of intellectual skills have been used. To some degree, evaluation can be considered a "floating" category, in that it can be used at each level of intellectual activity (Hunkins, 1972). C. Unfortunately, too often only the knowledge level in the cognitive domain is emphasized and evaluated. Students are taught facts and specifics and are then asked to repeat them in various ways (Chamberlain and Kelly, 1981).

D. 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 standpoints such as logical accuracy, consistency, and other internal criteria.

2. Evaluation in Terms of External Criteria - focus is on having students apply known criteria to judge various situations or conditions that he/she encounters or develops.

APPENDIX B

Personalological Instrument
DEMOGRAPHIC INFORMATION

Case no. _____

1. Social Security number__________________________

2. Name ______________________
   Address ______________________
   State, Zip ______________________
   Phone: ______________________

2. Gender ___ Female ___ Male

3. DOB ________

4. Ethnic background
   ___ Afro- ___ Asian- ___ White ___ Hispanic
   ___ Other

5. Major _____________

6. GPA ________

7. ACT ________

8. GEFT ________

9. DCAT Basic _____ Appl. _____ Critical _____
APPENDIX C

Letter Of Invitation
January 22, 1993

fname ~ lname~
address~

Dear fname~:

As a senior enrolled at The Ohio State University, you undoubtedly have experienced many teaching styles. It is no secret that each professor has his/her own distinct way of teaching. However, did you ever wonder why you preferred a particular style of teaching and felt frustrated or uncomfortable with other styles of teaching? This is because your learning style plays a big roll in the preference you have for learning.

In the College of Agriculture, we are interested in identifying our students' learning style. Having this information available allows us to share the group data with College of Agriculture faculty. Agriculture professors will then be able to use this information in adapting their teaching to meet the preferred learning style of students and minimize student frustration. In addition, we are interested in determining the learning characteristics and abilities of our students.

fname~, you have been selected to participate in this study. Your participation will prove to be invaluable for students such as yourself as they study with us in the College of Agriculture. We are always concerned about the quality of education our students are receiving and are certainly interested in improving classroom teaching.

We are requesting one and a half hours of your time. Two assessment instruments will be used to identify your learning style and characteristics. These instruments are not exams and will not affect you academically. Your results will be kept strictly confidential, but your score and its interpretation will be available to you personally, if you wish. At the end of the session, you will receive an Ohio Agriculture printed T-shirt as a token of our appreciation. Refreshments will also be served.

Several dates and times have been identified to try to accommodate your school/work schedule to gather this information. Please plan to attend one of the sessions. A post card, to be returned by January 29, is provided for you to make your session choice.

Thank you for your assistance.

Sincerely,

L. H. Newcomb
Associate Dean and
Director of Academic Affairs
APPENDIX D

Postcard
Please complete and return by January 29, 1993.

1. __ NO, I am unable to attend any session.
   ____ YES, I scheduled for myself and marked on my calendar
   the following date, time, and location:

2. Choose one date and time which best fits your schedule. They are:

   (Check one)                        (Circle one)
   ____ February 16, (Tuesday)        4:00 pm or 7:00 pm;
   ____ February 17, (Wednesday)      4:00 pm or 7:00 pm;
   ____ February 18, (Thursday)       4:00 pm or 7:00 pm;
   ____ February 22, (Monday)         4:00 pm or 7:00 pm.

All sessions will meet in Room 105 Agricultural Administration Building.

3. Your local telephone number______________________________
APPENDIX E

Letter Of Confirmation
February 9, 1993

2 ~ 1 ~
3 ~

Dear 2 ~:

Thank you for your willingness to participate in a session regarding the learning styles and abilities study. I am convinced that your participation will be of extreme value to the College of Agriculture faculty at the Ohio State University. Equally as important, you will gain knowledge of your own particular learning style which will serve you well in future learning settings.

This letter serves as a reminder and confirmation of the date, time, and location of the session you have selected. All you will need is a pencil.

According to your written or verbal response, the following date and time has been scheduled for you:

<table>
<thead>
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<th>Date</th>
<th>Time</th>
<th>Location</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td><strong>105 Agricultural Administration Building</strong></td>
</tr>
</tbody>
</table>

If for any reason, you have a conflict with your scheduled time, please call me for an alternate date at 292-6321 or 292-1354. I will be conducting all sessions.

Thank you for your help.

Sincerely,

Robert M. Torres
Graduate Associate
APPENDIX F

Special Session Handout
<p>| | |</p>
<table>
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<tr>
<td>Group Embedded Figure Test Score</td>
<td></td>
</tr>
<tr>
<td>Percent of Field-Dependents</td>
<td>34</td>
</tr>
<tr>
<td>Percent of Neutrals</td>
<td>18</td>
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<tr>
<td>Percent of Field-Independents</td>
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<tr>
<td>Group Mean Score</td>
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<td>Standard Deviation</td>
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National Norm

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<td>Mean</td>
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<tr>
<td>Females</td>
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<tr>
<td>Males</td>
<td>12.5</td>
</tr>
</tbody>
</table>

Learning Style

Field-Dependence / Field-Independence

Name ______________________

Learning Style defined:

...that consistent pattern of behavior and performance by which an individual approaches an educational experience.

The Ohio State University
College of Agriculture

Winter Quarter 1993
FIELD-DEPENDENT

...includes persons who are heavily influenced by the surrounding field.

**Characteristics of a FIELD-DEPENDENT LEARNER**

- Has a global perception
- Poor at analytical problem solving
- Highly sensitive and attuned to social environments
- Highly developed social skills
- Favors "spectator approach" to learning
- Adopts organization of information to be learned
- Extrinsically motivated
- Responsive to social reinforcement

FIELD-INDEPENDENT

...includes persons who are not influenced by the surrounding field.

**Characteristics of a FIELD-INDEPENDENT LEARNER**

- Perception of discrete parts
- Good at abstract analytical thought
- Individualistic and insensitive to emotions of others
- Poorly developed social skills
- Favors "inquiry" and independent study
- Provides own structure to facilitate learning
- Intrinsically motivated
- Unresponsive to social reinforcement
APPENDIX G

Letter to Non-Response Sample
March 26, 1993

2 ~ 1 ~
3 ~

Dear 2 ~:

We need your help! During Winter Quarter, 1993, I sent out a letter of invitation to selected students asking for their participation in a study on learning styles and characteristics. Our sessions were well attended, and we were pleased with the response.

However, to increase our ability to generalize the results, we need your help. Because of schedule and/or work conflicts or perhaps other reasons, you were unable to attend any of the scheduled sessions. It is this group of students who were unable to attend in which we are interested. We randomly selected sixteen students to be representative of the group which could not attend.

You are one of the sixteen students we need. It is vitally important that we get your participation. If convenient for you, we have scheduled two group data collection sessions on Tuesday, April 6, in room 205, Agricultural Administration Building. You are welcome to attend either the 10:00 am session or the 1:00 pm session. If the scheduled sessions are not convenient for you, we will seek an alternative date, time, and location.

I am requesting that you contact Bob Torres at 292-6321 to schedule the one hour and a half session with him. Schedule a time that is convenient to you any time of the day or evening, including weekends. If Bob does not receive a response from you, he will be calling you for a time to meet.

Thank you for your cooperation.

L. H. Newcomb
Associate Dean and
Director of Academic Affairs
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