LEARNING STYLE AND COGNITIVE ABILITY OF OAK HARBOR HIGH SCHOOL AGRICULTURAL EDUCATION STUDENTS

A Thesis
Presented in Partial Fulfillment of the Requirements for
the Degree of Master of Science in the
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* * * * *

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ABSTRACT

The purpose of the descriptive correlational study was to describe the learning style and cognitive abilities of students enrolled in Agricultural Education at Oak Harbor High School, Ohio. Furthermore, the study sought to relate learning style and cognitive abilities to specific student characteristics (grade level, cumulative grade point average, and gender).

The largest groups of Oak Harbor High School Agricultural Education students were freshman and male. In addition, the majority (67.9%) of the students were field dependent. Furthermore, the mean cumulative grade point average for Oak Harbor High School Agricultural Education students was 2.73 on a 4.00 scale.

Significant, positive, and substantial relationships were found between Group Embedded Figures Test (GEFT) scores and Application Ability and Spatial Ability. Significant, positive, and moderate relationships were found between GEFT score and Basic Cognitive Ability, Critical Thinking Ability, Verbal Ability, Quantitative Ability, and cumulative grade point average (CGPA). Significant, positive, and moderate relationships were found between CGPA and Basic Cognitive Ability, Application Ability, and Quantitative Ability. Significant, positive, and low relationships were found between: Grade Level and Basic Cognitive Ability, Application Ability, Critical Thinking Ability, Verbal Ability, and Quantitative Ability; and, CGPA and Critical Thinking Ability, Verbal Ability, and Spatial Ability. Significant, negative, and low relationships were found between Gender
and Basic Cognitive Ability, Application Ability, and Critical Thinking Ability. A significant, negative, and moderate relationship was found between Gender and Verbal Ability. Significant, negative, and low relationships were found between Gender and Basic Cognitive Ability, Application Ability, and Critical Thinking Ability.
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FIELDS OF STUDY

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>ii</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td>iv</td>
</tr>
<tr>
<td>Vita</td>
<td>vi</td>
</tr>
<tr>
<td>List of Tables</td>
<td>xi</td>
</tr>
<tr>
<td>List of Figures</td>
<td>xiii</td>
</tr>
<tr>
<td>Chapters</td>
<td></td>
</tr>
<tr>
<td>1. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Statement of the Problem</td>
<td>5</td>
</tr>
<tr>
<td>1.2 Purpose of the Study</td>
<td>5</td>
</tr>
<tr>
<td>1.3 Research Objectives</td>
<td>6</td>
</tr>
<tr>
<td>1.4 Definition of Terms</td>
<td>7</td>
</tr>
<tr>
<td>1.5 Assumptions</td>
<td>10</td>
</tr>
<tr>
<td>1.6 Limitations of the Study</td>
<td>11</td>
</tr>
<tr>
<td>1.7 Significance of the Problem</td>
<td>11</td>
</tr>
<tr>
<td>2. Review of Related Literature</td>
<td>14</td>
</tr>
<tr>
<td>2.1 Learning Styles</td>
<td>15</td>
</tr>
<tr>
<td>2.1.1 Learning Styles Defined</td>
<td>15</td>
</tr>
<tr>
<td>2.1.2 Categorization of Learning Styles</td>
<td>16</td>
</tr>
<tr>
<td>2.1.3 David Kolb</td>
<td>18</td>
</tr>
<tr>
<td>2.1.4 Anthony Gregorc</td>
<td>21</td>
</tr>
<tr>
<td>2.1.5 Kenneth and Rita Dunn</td>
<td>22</td>
</tr>
<tr>
<td>2.1.6 Herman Witkin</td>
<td>23</td>
</tr>
<tr>
<td>2.1.7 Field Dependence / Field Independence</td>
<td>25</td>
</tr>
</tbody>
</table>
2.1.8 Characteristics and Behaviors of Field
Dependent Learners .............................................. 28
2.1.9 Characteristics and Behaviors of Field
Independent Learners ............................................. 29
2.1.10 Relationships between Learning Style
and Grade Level (Age) ............................................. 31
2.1.11 Relationships between Learning Style
and Gender .......................................................... 31
2.1.12 Relationships between Learning Style
and Cumulative Grade Point Average (CGPA) ............ 33
2.1.13 Learning Styles Summary ................................. 35

2.2 Cognitive Abilities ............................................. 35

2.2.1 Origin of Cognitive Abilities .............................. 36
2.2.2 Cognitive Abilities Defined ............................... 37
2.2.3 Verbal Ability ............................................... 38
2.2.4 Mathematical or Quantitative Ability .................. 40
2.2.5 Spatial Ability .............................................. 41
2.2.6 Relationship between Cognitive Abilities
and Grade Level .................................................. 43
2.2.7 Relationship between Cognitive Abilities
and Gender ......................................................... 44

2.2.7.1 Verbal Abilities and Gender .......................... 45
2.2.7.2 Quantitative Abilities and Gender .................. 46
2.2.7.3 Spatial Abilities and Gender ........................ 47
2.2.7.4 Cognitive Ability Levels and Gender ............... 47

2.2.8 Relationships between Cognitive Abilities
and Cumulative Grade Point Average (CGPA) ............ 48
2.2.9 Cognitive Abilities Summary ............................. 49

2.3 Differences and Relationships between Learning Styles
and Cognitive Abilities ............................................ 49
2.4 Summary of Chapter 2 ....................................... 52

3. Methodology ..................................................... 54

3.1 Research Design .............................................. 54
3.2 Population and Sample ....................................... 55
3.3 Instrumentation ............................................... 55
3.3.1 Group Embedded Figures Test (GEFT) ...................... 56
  3.3.1.1 Validity of GEFT .................................. 57
  3.3.1.2 Reliability of GEFT ............................... 58

3.3.2 Developing Cognitive Abilities Test (DCAT) .............. 58
  3.3.2.1 Validity of DCAT .................................. 63
  3.3.2.2 Reliability of DCAT ............................... 63

3.3.3 Brief Information Sheet .................................. 63

3.4 Data Collection ............................................... 64
3.5 Data Analysis .................................................. 67
  3.5.1 Group Embedded Figures Test (GEFT) .................. 67
  3.5.2 Developing Cognitive Abilities Test (DCAT) .......... 67
  3.5.3 Research Objectives’ Analyses ........................ 69

3.6 Summary of Chapter 3 ......................................... 72

4. Findings .......................................................... 73
  4.1 Personological Data ........................................... 73
  4.2 Students’ Learning Style ..................................... 75
  4.3 Students’ Level of Cognitive Abilities .................... 76
  4.4 Students’ Specific Content Area Cognitive Abilities .... 80
  4.5 Correlation between Group Embedded Figures Test
      (GEFT) Score and Levels of Cognitive Ability .......... 83
  4.6 Correlation between Group Embedded Figures Test
      (GEFT) Score and Content Area Cognitive Ability ....... 84
  4.7 Correlation between Group Embedded Figures Test
      (GEFT) Score and Grade Level, Cumulative Grade
      Point Average (CGPA), and Gender ....................... 85
  4.8 Correlation between Levels of Cognitive Ability
      (Basic Cognitive Ability, Application Ability,
      and Critical Thinking Ability) and Grade Level,
      Cumulative Grade Point Average (CGPA), and Gender .. 86
  4.9 Correlation between Content Area Cognitive Ability
      and Grade Level, Cumulative Grade Point Average
      (CGPA), and Gender ........................................ 88

5. Summary, Conclusions, Implications, and Recommendations .... 90
  5.1 Summary ....................................................... 90
5.1.1 Purpose of the Study ........................................... 90
5.1.2 Research Objectives ........................................ 90
5.1.3 Research Design ........................................... 92
5.1.4 Population and Sample ..................................... 92
5.1.5 Instrumentation and Data Collection ................. 93
5.1.6 Data Analysis ............................................. 94
5.1.7 Summary of Findings ..................................... 94

5.1.7.1 Personological Data ..................................... 94
5.1.7.2 Students' Learning Style ................................ 95
5.1.7.3 Students' Level of Cognitive Abilities ............. 96
5.1.7.4 Students' Specific Content Area
Cognitive Abilities ........................................... 97
5.1.7.5 Correlation between Group Embedded
Figures Test (GEFT) Score and Levels
of Cognitive Ability ......................................... 97
5.1.7.6 Correlation between Group Embedded
Figures Test (GEFT) Score and Content
Area Cognitive Ability ..................................... 98
5.1.7.7 Correlation between Group Embedded
Figures Test (GEFT) Score and Grade
Level, Cumulative Grade Point Average (CGPA), and Gender ................. 99
5.1.7.8 Correlation between Levels of
Cognitive Ability (Basic Ability, Application
Ability, Critical Thinking Ability) and Grade
Level, Cumulative Grade Point Average (CGPA), and Gender ................. 99
5.1.7.9 Correlation between Content Area
Cognitive Ability and Grade Level,
Cumulative Grade Point Average (CGPA),
and Gender .................................................. 101

5.2 Conclusions .................................................. 102
5.3 Implications .................................................. 104
5.4 Recommendations .......................................... 107

5.4.1 Recommendations for Instruction ....................... 107
5.4.2 Recommendations for Further Research .............. 109

List of References ............................................. 111
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Independent Sample T-Test Results: Comparison of Specific Content Area Mean Scores between Two Samples of Freshman Students</td>
<td>65</td>
</tr>
<tr>
<td>3.2</td>
<td>Independent Sample T-Test Results: Comparison of Level of Cognitive Ability Mean Scores between Two Samples of Freshman Students</td>
<td>65</td>
</tr>
<tr>
<td>4.1</td>
<td>Grade Level of Oak Harbor High School Agricultural Education Students</td>
<td>74</td>
</tr>
<tr>
<td>4.2</td>
<td>Gender of Oak Harbor High School Agricultural Education Students</td>
<td>74</td>
</tr>
<tr>
<td>4.3</td>
<td>Cumulative Grade Point Averages of Oak Harbor High School Agricultural Education Students</td>
<td>75</td>
</tr>
<tr>
<td>4.4</td>
<td>Group Embedded Figures Test (GEFT) Scores of Oak Harbor High School Agricultural Education Students</td>
<td>77</td>
</tr>
<tr>
<td>4.5</td>
<td>Learning Style of Oak Harbor High School Agricultural Education Students</td>
<td>77</td>
</tr>
<tr>
<td>4.6</td>
<td>Basic Cognitive Ability Scores of Oak Harbor High School Agricultural Education Students</td>
<td>78</td>
</tr>
<tr>
<td>4.7</td>
<td>Application Ability Scores of Oak Harbor High School Agricultural Education Students</td>
<td>79</td>
</tr>
<tr>
<td>4.8</td>
<td>Critical Thinking Ability Scores of Oak Harbor High School Agricultural Education Students</td>
<td>80</td>
</tr>
<tr>
<td>4.9</td>
<td>Verbal Ability Scores of Oak Harbor High School Agricultural Education Students</td>
<td>81</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Kolb’s Experiential Learning Cycle</td>
<td>19</td>
</tr>
<tr>
<td>2.2</td>
<td>Kolb’s Learning Style Inventory</td>
<td>20</td>
</tr>
<tr>
<td>2.3</td>
<td>Gregorc’s Learning Styles Model</td>
<td>21</td>
</tr>
<tr>
<td>2.4</td>
<td>Witkin’s Field Dependent - Field Independent Model</td>
<td>24</td>
</tr>
<tr>
<td>3.1</td>
<td>Subtests, Number of Items, and Time Limits for the DCAT, Level L</td>
<td>59</td>
</tr>
<tr>
<td>3.2</td>
<td>Relationship between Bloom’s Taxonomy and the Developing Cognitive Abilities Test</td>
<td>60</td>
</tr>
<tr>
<td>3.3</td>
<td>Item Structure for the Developing Cognitive Abilities Test</td>
<td>68</td>
</tr>
<tr>
<td>3.4</td>
<td>Davis’ Correlation Descriptions</td>
<td>72</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

Krumboltz (1987) claimed that an educator’s primary goal should be to develop a love of lifelong learning among learners. However, Krumboltz (1987) stated that, in practice, educators do the opposite. If educators wanted to make learners dislike school, learning, and teachers, there would be no better system than the educational system that is currently designed (Krumboltz, 1987).

It is common knowledge among educators that learners learn differently (Dunn & Griggs, 1989). However, educators most often require that learners learn exactly the same way, at the same time and pace, and in identical environments. Educators generally apply consistent pressure on learners by publicly questioning, correcting, and teaching in ways that appeal to the educators themselves, rather than to the variety of styles and abilities that exist in every classroom (Dunn & Griggs, 1989).

Teaching and learning practices in education urgently need improvement (Claxton & Murrell, 1987). Take for example, the recommendations of several national commissions on higher education (A Nation at Risk, 1983; America 2000, 1991; Goals 2000, 1994; Seven Priorities of the USDE, 1997) and the difficulties educators face in preparing students for life in the 21st century (Claxton & Murrell, 1987). The concepts of learning styles and cognitive
abilities seem to be viable medications to some of the symptoms and problems recognized in today's educational systems.

**Learning Styles**

Information on learning styles can help students, teachers, and faculty in many ways (Reiff, 1992; Claxton & Murrell, 1987; Guild & Garger, 1985). Knowledge of learning styles can help to reduce the frustrations of teachers and students (Reiff, 1992). In addition, understanding different learning styles can improve learners' self-concept and achievement (Reiff, 1992). When individual learning style differences were considered, learners had higher academic achievement, a more positive attitude, and an improved self-concept (Reiff, 1992; Dunn, Beaudry, & Klavas, 1989; Keefe, 1987; Gregorc & Butler, 1984; Claxton & Ralston, 1978).

Understanding learning styles could aid teachers in becoming better planners in order to meet the needs of their learners (Reiff, 1991; Cruickshank & Sheffield, 1988; McCutcheon, 1980). A teacher with knowledge of learning styles is more likely to plan appropriate lessons that could potentially accommodate the diverse learners in the classroom (Reiff, 1992). Through planning appropriate lessons and including a variety of strategies, a teacher will most likely improve instruction (Reiff, 1992; Borko, 1987; Lalik & Niles, 1990).

A thorough understanding of learning styles can also improve communication between teachers and learners. Knowledge of learning styles can be utilized as a powerful vehicle for communication between teachers and learners (Reiff, 1992). Knowledge of learning styles, then, is important to counselors, teachers, and administrators who would like to provide a more supportive, diverse, and effective learning environment in their schools.
(Keefe, 1988). Learning style seems to be the key to opening the door for principals, teachers, and learners to create a caring and effective school, a place where learners and learning are important, and where every learner can be reasonably successful in acquiring the knowledge and skills necessary for a productive, fruitful life (Keefe, 1988).

A primary goal of schools is to educate people. Therefore, education is a people business (Guild & Garger, 1985). Furthermore, if education is a people business, and it is evident that people are different, then education is a business about the diversity of people (Guild & Garger, 1985). Even though the existence of diversity in schools is verbally accepted, it is also widely recognized how often this diversity is ignored in practice (Guild & Garger, 1985). Accepting the diversity of learning styles among learners can help create the environment and experiences that will enable and encourage each learner to reach his or her full potential (Guild & Garger, 1985).

**Cognitive Abilities**

Torres (1999) indicated that since the formation of public education, no other student outcomes have been more cherished than a student’s ability to reason, solve problems, and think independently. In addition, Cano (1988) reported that public schools should be dedicated to the preservation of society through the education of our youth. Furthermore, it was imperative that “public school teachers teach the fundamental skills and develop attitudes and habits that will help the student to be a useful citizen in our democracy” (Cano, 1988, p. 1).

The National Commission on Excellence in Education prepared a report, *A Nation at Risk* (1983), which brought about an awareness that the educational needs of learners in
America were not being met. Areas of specific importance, as indicated by the Commission, were problem solving ability and critical thinking skills of learners. The Commission reported that sixty-five (65) percent of the group studied could not solve mathematical problems that required more than one step. Furthermore, the Commission reported that many learners could not draw inferences from written materials. These findings, along with others, have influenced the Commission to make recommendations in education to improve learners' critical thinking skills, problem solving abilities, and higher order thinking abilities.

Teaching learners how to analyze, think critically, and solve problems has been a goal of educators in agriculture (Cano, 1988; Flores, 1995; Miller, 1989; Newcomb & Trefz, 1987; Torres, 1993), as well as general education. Harl (1980) suggested that every learner of agriculture should possess the ability to "... think and reason - creatively, analytically, thoroughly and with reasonable alacrity" (p. 5). Furthermore, Poulton (1985) purported that quality agricultural education programs should develop and teach learners to think logically and apply problem solving techniques where applicable.

Despite all of this, educational literature suggested that emphasis in schools was placed on teaching learners facts, even though teachers and curriculum planners agreed that teaching learners to think was extremely important (Gall, 1970; Roberts, 1974, cited in Cano, 1988). In addition, Cano and Martinez (1991) claimed that past research has indicated that most students showed little evidence of using critical thinking abilities when solving problems. In fact, Day (1981, cited in Cano & Martinez, 1991) purported that most students continued to operate in a concrete operational manner. Furthermore, Cano (1988) stated that agricultural educators did not know at which level of cognition learners were performing, nor did they know their learners' cognitive abilities.
Statement of the Problem

Despite a wealth of well conducted research, schools continue to function in the “dark ages” in terms of the teaching-learning process (Dunn & Dunn, 1978). Extensive data verified that repetitive use of identical methods, resources, or grouping procedures could prevent or block learning for the majority of learners (Dunn & Dunn, 1978). Schools do relatively well in collecting information about “what learners know.” However, by combining “what learners know” with profiles of “the way learners learn,” teachers, counselors, and teacher advisors are given the opportunity to do a more effective job of working with individual learners (Keefe, 1988).

As identified, much research has been done in the areas of learning styles (Witkin, 1973; Dunn and Dunn, 1979; Messick, 1970; Gregorc, 1979) and cognitive abilities (Bloom et al., 1956; Torres, 1993; Caplan, Crawford, Hyde, & Richardson, 1997; Halpern, 1992; Piaget, 1952), yet, the question still remains: What is the relationship between learning styles and cognitive abilities? Furthermore, little evidence exists which describes learning styles and cognitive abilities among students enrolled in public high schools.

Purpose of the Study

The purpose of the study was to describe the learning style and cognitive abilities of students enrolled in Agricultural Education at Oak Harbor High School. Furthermore, the study sought to relate learning style and cognitive abilities to specific student characteristics.
Research Objectives

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

1. Describe students enrolled in Agricultural Education at Oak Harbor High School based on the following personological characteristics: grade level, gender, and cumulative grade point average (CGPA).

2. Determine the learning style of students enrolled in Agricultural Education at Oak Harbor High School as measured by the Group Embedded Figures Test (GEFT).

3. Determine the level of cognitive abilities (Basic, Application, and Critical Thinking) of students enrolled in Agricultural Education at Oak Harbor High School as measured by the Developing Cognitive Abilities Test (DCAT), Level L.

4. Determine the content area cognitive abilities (Verbal, Quantitative, and Spatial) of students enrolled in Agricultural Education at Oak Harbor High School as measured by the DCAT, Level L.

5. Describe the relationships between learning style utilizing the GEFT and levels of cognitive abilities (Basic, Application, and Critical Thinking) utilizing the DCAT, Level L, of students enrolled in Agricultural Education at Oak Harbor High School.

6. Describe the relationship between learning style utilizing the GEFT and content area cognitive abilities (Verbal, Quantitative, and Spatial) utilizing the DCAT, Level L, of students enrolled in Agricultural Education at Oak Harbor High School.

7. Describe the relationship between learning style utilizing the GEFT and selected student characteristics (grade level, gender, cumulative grade point average) of students enrolled in Agricultural Education at Oak Harbor High School.
8. Describe the relationship between level of cognitive abilities (Basic, Application and Critical Thinking) utilizing the DCAT, Level L, and selected student characteristics (grade level, gender, cumulative grade point average) of students enrolled in Agricultural Education at Oak Harbor High School.

9. Describe the relationship between content area cognitive abilities (Verbal, Quantitative, and Spatial) utilizing the DCAT, Level L, and selected student characteristics (grade level, gender, cumulative grade point average) of students enrolled in Agricultural Education at Oak Harbor High School.

**Definition of Terms**

The following operational definitions apply strictly to the purposes of the current study. The definitions were not intended to be extrapolated to other contexts.

**Learning Style:** Learning style was operationally defined as field dependent or field independent. Furthermore, field dependence and field independence was determined by an individual’s score on the Group Embedded Figures Test (GEFT) (Oltman, Raskin, & Witkin, 1971).

**Cognitive Ability:** An individual’s ability to succeed at certain tasks in the future if that individual were given proper instruction and if that individual were also motivated to learn and demonstrate the skills needed to perform the task (Halpern, 1992).

**Verbal Ability:** An individual’s ability to: decipher the meanings of words in the form of definitions, synonyms, or antonyms; appropriately
use words and phrases in the construction of meaning in sentences; and, perceiving interrelationships among a series of statements, making inferences from context, or forming conclusions through propositional reasoning about given information (Beggs & Muow, 1989). Furthermore, verbal ability was determined by an individual’s score (zero (0) to twenty-seven (27)) on the Developing Cognitive Abilities Test, Level L, Verbal subtest.

**Quantitative Ability:** An individual’s ability to: understand arithmetic operations of addition, subtraction, multiplication, and division along with basic geometric and trigonometric operations; perceive mathematical relationships embedded in the logic of problems, retrieve the appropriate mathematical operation from memory, and apply the principle to obtain the solution; and, transform the information into relationships that will correctly solve a problem (Beggs & Muow, 1989). Furthermore, quantitative ability was determined by an individual’s score (zero (0) to twenty-seven (27)) on the Developing Cognitive Abilities Test, Level L, Quantitative subtest.

**Spatial Ability:** An individual’s ability to: recognize and retain such characteristics of size, shape, symmetry, and pattern; estimate or predict what would occur when one or more objects change
in location or position; and, make abstract (mental) transformations of objects (Beggs & Muow, 1989). Furthermore, spatial ability was determined by an individual’s score (zero (0) to twenty-seven (27)) on the Developing Cognitive Abilities Test, Level I, Spatial subtest.

**Basic Ability:** Analogous to Bloom’s (1956) levels of Knowledge and Comprehension, which were defined as an individual’s ability to remember, translate, interpret, and, extrapolate.

**Application Ability:** Analogous to Bloom’s (1956) level of Application which was defined as an individual’s ability to use abstractions in specific situations.

**Critical Thinking**

**Ability:** Analogous to Bloom’s (1956) levels of Analysis and Synthesis which were defined as an individual’s ability to break down concepts into components and use parts or elements to form a whole.

**Content Area:** Referred directly to scores yielded, or output, on Verbal, Quantitative, and Spatial areas. Possible scores in the three (3) content areas of the Developing Cognitive Abilities Test (DCAT) ranged from zero (0) to twenty-seven (27), inclusively.
Subtest: Referred only to specific portions of the Developing Cognitive Abilities Test (DCAT), such as Verbal Subtest, Quantitative Subtest, and Spatial Subtest.

Assumptions

Some assumptions need to be made regarding the current study. First, it was assumed that the population of this study, Agricultural Education students at Oak Harbor High School, was representative of all students at Oak Harbor High School and assumed to be representative of other high school students of agriculture. Second, it was assumed that all participants in the study took the two tests seriously and completed the tests to the best of their ability.

Considering the research on the relationships between learning styles and ages, and the lack of research on the relationships between learning styles and grade levels, it was necessary to assume the ages of students at Oak Harbor High School were representative of the average ages of students at each particular grade level. The assumed ages of students and their respective grade levels were: ninth (9th) graders were assumed to have been between the ages of fourteen (14) and fifteen (15); tenth (10th) graders were assumed to have been between the ages of fifteen (15) and sixteen (16); eleventh (11th) graders were assumed to have been between the ages of sixteen (16) and seventeen (17); and, twelfth (12th) graders were assumed to have been between the ages of seventeen (17) and eighteen (18).

Furthermore, an additional assumption regarding age must be made. Based on the research of Witkin, Oltman, Raskin, and Karp (1971) and Witkin, Goodenough, and Karp
(1967), it was assumed that learning styles of individuals were stable between the ages of fourteen (14) and eighteen (18).

**Limitations of the Study**

The study was limited to only one (1) high school due to limitations of funding and time allocated to the researcher. Oak Harbor High School was chosen for data collection due to accessibility to the researcher. The study was also limited to the students present at Oak Harbor High School on the days the testing was administered. Consequently, the results of the study were generalizable only to those students included in the sample.

**Significance of the Problem**

Diagnosing learning styles is quite possibly one of the most neglected functions of schooling (Keefe, 1988; Dunn & Dum, 1978). Yet, learning style opens the door to a more personalized approach to schooling: to learner advisement and placement; to improvement of learner skills; to successful instructional strategy; and, to meaningful evaluation of teaching and learning (Keefe, 1988).

Keefe (1988) indicated that when efforts were made to match an individual’s learning style with an instructional environment, the outcomes were positively affected. Also, research evidence indicated that when teachers adjusted instruction to diagnosed learning style differences, academic achievement increased, attitude toward learning was more positive, and fewer discipline problems occurred (Keefe, 1988).

"If individuals have significantly different learning styles - as they appear to have - is it not unprofessional, irresponsible, and immoral to teach all students the same lesson in
the same way without identifying their unique strengths and then providing responsive instruction?" (Dunn, 1993, p.30). Therefore, the more we know and understand the learner, the more effective and efficient the teaching and learning process will be. It is common knowledge among educators that people think and act differently, however, that fact, all too often, becomes lost in the educational process (Reiff, 1992).

Nelson and Scanlon (1977; cited in Cano, 1988) reported that preparing students for work was an important function of education. However, recent studies (Cano, 1988; Miller, 1989; Miller & Cano, 1986; Torres, 1993) have indicated that students of agriculture, upon graduation, were ill-prepared in terms of knowledge and cognitive abilities for the workplace. Miller and Cano (1986) found that agribusiness owners/managers indicated that students graduating from high school Agricultural Education courses did not possess the knowledge and skills required for today's agriculture. Furthermore, Torres (1993) and Flores (1995) found that there was room for improvement in terms of students' cognitive abilities. The twenty-first (21st) century will not only require, but demand from agriculturalists, the latest knowledge and skills about agricultural concepts (Cano, 1988).

Not only was the lack of knowledge and skills a problem of learners upon graduation, but also critical thinking abilities, problem solving abilities, and higher order thinking skills were identified as being underdeveloped (Miller, 1989). Miller (1989) reported that "Teaching students how to think, or developing their critical thinking and problems solving skills..." (p. 5) was identified as a goal of educators. In addition, Bransford and Vye (1989) claimed that "...many traditional approaches to instruction do not help students make the transformation from 'knowing that' something is true to 'knowing how' to think, learn, and solve problems" (p. 193). Lochhead and Clement (1979) claimed that "We should be
teaching students how to think; instead we are primarily teaching them what to think” (p. 1).

Furthermore, Bloom, Engelhart, Furst, Hill, & Krathwohl (1956) reported that although the acquisition of basic information or knowledge was recognized as an important outcome of education, what was needed was the development of critical thinking skills and problem solving abilities. In conclusion, Bloom et al. (1956) stated that “much emphasis must be placed in the schools on the development of generalized ways of attacking problems and on knowledge which can be applied to a wide range of situations. That is, we have the task of preparing individuals all for problems that cannot be foreseen in advance, and about all that can be done under such conditions is to help the student acquire generalized intellectual abilities and skills which will serve him [sic] well in many new situations” (p. 40).

Limited research has been conducted regarding the relationship between learning style and cognitive ability. Torres (1993) conducted such a study with college seniors. Flores (1995) also studied the relationship between learning style and cognitive ability. Flores studied learning style and cognitive ability among high school occupational Home Economics students in Puerto Rico. Given the aforementioned information, there continues to be a need for research on learning style and cognitive ability among high school Agricultural Education students. The current study aims to fulfill the aforementioned need.
CHAPTER 2
REVIEW OF RELATED LITERATURE

The purpose of the study was to describe the learning style and cognitive abilities of students enrolled in Agricultural Education at Oak Harbor High School. Furthermore, the study sought to relate learning style and cognitive abilities to specific student characteristics.

There was an abundance of literature dealing with learning styles. The first portion of this review of related literature will focus on learning styles. Due to the inconsistent nature of research on learning styles, the learning styles portion of this review of related literature was structured so as to present a prominent learning styles researcher, followed by his or her interpretation of learning styles. At the conclusion of the learning styles portion of the review of related literature, an interpretation of field dependence/field independence will be presented.

The middle portion of this review of related literature will focus on cognitive abilities. Literature on cognitive abilities was rather sparse. It was the goal of the researcher to shed some insight on the term “cognitive abilities” in the middle portion of this review of related literature. The cognitive abilities portion of this review of related literature aims to give a brief introduction to cognitive abilities, then provide information on the three primary cognitive abilities studied herein: verbal ability, mathematical or quantitative ability, and spatial ability.
Finally, this review of related literature will conclude with differences and relationships between learning styles and cognitive abilities. Also included within this final section will be relationships found between learning styles and cognitive abilities.

**Learning Styles**

Research on learning styles has both promise and problems (Claxton & Murrell, 1987). Much of the literature on learning styles was presented with unresolved issues, both theoretical and practical. Some researchers believed that “style is the most important concept to demand attention in education” (Guild & Garger, 1985, pp. viii). Yet, others believed that researchers did not yet have a grasp on the reality of the concept of learning styles (Curry, 1983). At the root of the problem with learning styles research was the fact that different researchers perceived and interpreted the word “learning style” in many different ways.

**Learning Styles Defined**

Rita and Kenneth Dunn (1978) defined learning styles as the way individuals concentrated on, absorbed, and retained new information or skills. Gregorc (1979) indicated that learning styles were “distinctive behaviors which serve as indicators of how a person learns from and adapts to his [sic] environment” (p. 234). Claxton and Ralston (1978) defined learning style as “a student’s consistent way of responding to and using stimuli in the context of learning” (p. 71). Ausubel, Novak, and Hanesian (1978) referred to learning styles as the “self-consistent, enduring individual differences in cognitive organization and functioning” (p. 203). Yet, one of the most comprehensive definitions of learning style was offered by Keefe. Keefe (1979) delineated learning styles as “characteristic cognitive,
affective, and physiological traits that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment” (p. 4).

Many other researchers (Witkin, 1976; Messick, 1970; Vernon, 1971; Kogan, 1971) defined learning style under the more specific term cognitive style. Nearly as many variations of the term cognitive style existed as there were variations of learning style. Witkin (1976) defined cognitive style as “cognitive characteristic modes of functioning that we reveal through our perceptual and intellectual activities in a highly consistent and pervasive way” (p. 39). Messick (1970) indicated that cognitive style represented “a person’s typical modes of perceiving, remembering, thinking, and problem solving” (p. 188).

Vernon (1973) referred to cognitive style as “a superordinate construct... involved in many cognitive operations [that] accounts for individual differences in a variety of cognitive, perceptual, and personality variables” (p. 141). Finally, Kogan (1971) delineated cognitive style very similar to Messick (1970) as “an individual’s variation in modes of perceiving, remembering, and thinking, or as distinctive ways of apprehending, storing, transferring, and utilizing information” (p. 141).

Categorization of Learning Styles

Not only did researchers define learning styles differently, they also categorized, classified, and labeled learning styles inconsistently. Some of the categories or labels in which researchers grouped distinct learning styles were field dependent/global or field dependent/analytical (Ramirez & Castaneda, 1974; Witkin, 1976), concrete-abstract and random-sequential (Gregorc, 1979), leveling versus sharpening (Holzman, 1952; Klein & Schlesinger, 1951) and sixteen (16) different personality types (Myers & Briggs, 1977).
Rita and Kenneth Dunn (1978) described four groups of elements in which learners had distinct preferences: environmental (sound, light, temperature, and design), emotional (motivational, persistence, responsibility, and a need for structure), sociological (working alone, with others, or with an adult), and physical (perceptual strengths, including visual, auditory, tactile, and kinesthetic; intake, time of day, and need for mobility). Kogan (1976) referred to attentional and perceptual elements of style as “impulsive” and “reflective” and “category breadth” (Wallach & Kogan, 1965).

Holzman (1952), and Klein and Schlesinger (1951), studied an individual’s tendencies in assimilating fragmented stimuli, and labeled these individuals as “levelers” or “sharpeners.” Levelers tended to: assimilate new stimuli with familiar elements; minimize perceived differences; and, experience two different stimuli as the same. Sharpeners, on the other hand, tended to: assimilate new stimuli as different; maximize perceived differences; and, perceive small gradients of differences between stimuli.

Brumby (1982) has summarized some of the consistent assumptions that have been made by many researchers in regards to learning style. Brumby claimed that each individual possessed only one learning style, existing on a bipolar spectrum. Every individual could be consistently placed on this bipolar spectrum. In addition, Brumby reported that there were different styles, but an individual had only one. An individual’s learning style was stable across situations and time. Furthermore, Brumby concluded that different learning styles could all be present in individuals in differing degrees. Therefore, individuals could be characterized as having certain “amounts” of these differing styles. Likewise, Brumby claimed that there were different learning styles and an individual’s behavior was dependent upon a particular assigned task. Brumby’s (1982) final claim implied that there was
metacognitive control over which problem-solving approach would be utilized on a particular task.

Failure to find substantial correlations across different measures of learning style indicated that there were multiple dimensions of learning style, there were multiple learning styles, or that the measures of learning style were not reliable and valid indices of a well defined construct (Green, 1985). Furthermore, major obstacles to improving instructional effectiveness through an understanding of learning styles seemed to be the lack of agreement as to the definitions of important concepts and the methods of measurement in the learning styles field (Sims & Sims, 1995). Claxton and Murrell (1987) believed it was doubtful that any final agreement could be reached on cognitive styles and learning styles until further research had resulted in a more refined theoretical base. Thus, it was imperative to review the interpretation and ideas of some researchers (Kolb, Gregorc, Dunn & Dunn, and Witkin) of learning styles independently.

David Kolb

Kolb’s learning style theory differed from other researchers in that it was developed from the theory of “experiential learning” (Kolb, 1984, cited in Claxton & Murrell, 1987). Based on the combination of the works of Dewey (1938), who emphasized that learning be grounded in experience, and Lewin (1951), who stressed a person’s need for being active in learning, and Piaget (1952), who described intelligence not so much as being innate, but rather the result of the interaction of the person and the environment, Kolb described learning as a cyclical four step process. Kolb called this process the experiential learning cycle (Figure 2.1).
Figure 2.1: Kolb’s Experiential Learning Cycle (Kolb, 1984)

The first step in the learning cycle was a concrete experience. During the concrete experience step, the learner was involved in a learning experience. In the second step, reflective observation, the learner reflected on the experience from different perspectives. During abstract conceptualization, the third step, learners created generalizations or principles that integrated observations into theories. And finally, the learners engaged in active experimentation. In active experimentation, learners tested what they had learned in new, more complex situations. The result of the experimentation tested was another concrete experience and the process started back with the first step, thus the cyclical pattern.

The four points on the experiential learning cycle were modes of dealing with information or adapting to the world. From the positioning of these points, Kolb developed four learning styles (Figure 2.2).
The first, divergers, perceived information concretely and processed it reflectively. Divergers were called imaginative learners because they integrated experiences with the self and needed to be personally engaged in the learning process. The second group, assimilators, perceived information abstractly and processed it reflectively. Assimilators were pragmatists and placed a high value on skills development and problem solving. Convergers made up the third group. Convergers perceived information abstractly and processed it actively. Convergers learned by sequential thinking and were attentive to detail and thoroughness. The fourth group, accommodators, perceived information concretely and processed it actively. Accommodators were dynamic learners who valued change, risk-taking, and flexibility (Claxton & Murrell, 1987; Griggs, 1991; Kolb, 1984).
Anthony Gregorc

Gregorc maintained that mind qualities emerged as dualities. Gregorc discerned two sets of dualities that explained the acquisition of information. The first set, abstract and concrete, dealt with the way a learner perceived things. The second set, sequential and random, dealt with the way a learner ordered things. Gregorc stated that everyone had the qualities of sequential, random, abstract, and concrete, but most people had innate tendencies toward one aspect of a duality rather than the other (Gregorc, 1979). The two sets of dualities resulted in four learning styles: abstract-sequential; abstract-random; concrete-sequential; and, concrete-random (Figure 2.3).

The abstract-sequential learner was easily able to decode written, verbal, and image symbols. Symbols and pictures were important to the abstract-sequential learner, as were presentations that were rational, substantive, and well organized.

![Diagram showing the Gregorc Learning Styles Model]

Figure 2.3: Gregorc's Learning Styles Model (Gregorc, 1979)
The abstract-random learner was skilled in sensing and interpreting atmosphere and mood. For the abstract-random learner, the medium was associated with the message, and a speaker's manner, delivery, and personality were as important as what was spoken. Information was gathered in an unstructured manner, reflected upon, and then organized into a pattern that made sense to the abstract-random learner.

The concrete-sequential learner preferred hands-on experiences that used all five senses. Concrete-sequential learners preferred step-by-step directions and well-ordered presentations and would defer to authority and guidance in the learning environment.

The concrete-random learner liked to experiment, came to the solution of the matter quickly, and used intuition in drawing conclusions. Concrete-random learners preferred a trial and error approach to gathering information and did not welcome teacher intervention.

Gregorc (1979) believed that although learning styles emerged innately, learners could develop other styles, especially those which had strong tendencies towards one end of the duality. Gregorc stated that the most successful learners were those whose learning styles matched the style of the teacher (Gregorc, 1977). However, "too much matching can... lead to boredom" (p. 26). Also, long periods of mismatch could lead to major emotional and physical problems (Gregorc, 1979).

Kenneth and Rita Dunn

Dunn and Dunn have been actively promoting learning styles based instruction for more than twenty (20) years. Kenneth and Rita Dunn developed their own instrument to measure or assess learning style, the Learning Style Inventory (LSI). The LSI was the most
widely used instrument in elementary and secondary schools (Keefe, 1982). The LSI measured students on four major elements:

1. The immediate instructional environment: sound; light; temperature; and seating.

2. Each person's emotionality: motivation; persistence; responsibility (conformity vs. nonconformity); and, structure (internal vs. external).

3. Social preferences: learning alone; in pairs; with peers; in a small team; or, with an adult.

4. Physiological uniqueness: perceptual preferences (auditory, visual, tactile, kinesthetic); intake (eating, drinking, chewing, biting); time of day energy highs and lows; and, mobility versus passivity needs (Dunn, 1993).

Dunn and Dunn (1979) believed that both achievement and motivation improved when learning and teaching styles were matched. Teachers normally taught as they learned, often feeling that there was only one right way to learn and hence only one right way to teach. Dunn and Dunn (1979) believed that modification of teaching style was difficult and could be reached by the teacher understanding why one teaching style could not effectively reach all students. The elements of teaching that could be adapted to student preferences were, as indicated by Dunn and Dunn (1978): instructional planning; student grouping; room design; teaching environment; teaching characteristics; teaching methods; and, evaluation.

Herman Witkin

Herman A. Witkin, known as the father of field dependence/field independence (Reiff, 1992), has conducted “the most extensive and in-depth research on cognitive style conducted in the last fifty years” (Guild & Garger, 1985, p. xii). Witkin’s (1976) bipolar
construct of field dependence and field independence, which measured the extent to which a person was influenced by a surrounding field, has greatly influenced the field of learning styles. Tools that have been developed to study field dependence-field independence are the Rod-and-Frame Test (RFT), the Body-Adjustment Test (BAT), and the Group Embedded Figures Test (GEFT). The GEFT identified how accurately one could pick out a simple object within the context of more complex figures (Claxton & Murrell, 1987). The number of correct responses to the GEFT determined an individuals “field dependence” or “field independence” (Figure 2.4).

![Field Dependent - Field Independent Model](image)

Figure 2.4: Witkin’s Field Dependent - Field Independent Model (Witkin, 1976)

One must understand that the world is not filled with only two types of people: field dependents and field independents (Claxton & Murrell, 1987). “Rather, a person’s standing on this dimension is described by his or her position relative to the mean” (Claxton & Murrell, 1987, p. 9). An individual’s field dependence or field independence seems to develop out of a combination of genetic factors, socialization, and childhood experiences (Witkin, 1976).

Those individuals who were field dependent, or global, had more difficulty isolating a shape from a surrounding field, perceived things as a whole, were more influenced by and
sensitive to their environment, used surroundings to process information, made broad general
distinctions among concepts, were people-oriented, and learned material in a social context.
Individuals that were field independent, or analytical, perceived things in parts rather than
as a whole, functioned more autonomously, imposed structure or restrictions on information
and concepts, saw little overlap, and had an impersonal relationship to the world (Anderson

Field Dependence/Field Independence

The learning style dimension of field dependence and field independence has been
the most researched of learning style dimensions and has been perceived as the most
applicable to educational situations (Doebler & Eicke, 1979; Garton, 1993; Goldstein &
Blackman, 1978; Guild & Garger, 1985; Messick, 1976; Reiff, 1992; Witkin, Dyk, Paterson,
Goodenough, & Karp, 1962; Witkin, Lewis, Hertzman, Machover, Meissner, & Wapner,
1954; Witkin, Moore, Goodenough, & Cox, 1977a; Witkin, Moore, Goodenough, Friedman,
Owen, & Raskin, 1977b). Herman Witkin, known as the father of field dependence/field
independence (Reiff, 1992), determined that a field dependent individual was dominated by
the surrounding field and was more global. A field independent individual was not distracted
by the surrounding field and was more analytical (Reiff, 1992; Witkin, 1973; Witkin, 1976;

Earliest research in field dependence and field independence, shortly after World War
II, sought to determine why some pilots became disoriented and flew their planes upside
down when sight of the ground was lost (Guild & Garger, 1985). The fact that some World
War II pilots flew their planes upside down after losing sight of the ground was an indication
that those pilots were strongly influenced by their surroundings in interpreting their orientation in space.

In order to assess an individual’s perception of his or her own orientation in space, Witkin and Asch (1948; Witkin, 1948) developed the Body Adjustment Test (BAT). In the BAT, an individual was seated in a chair within a small, specially designed room. Both the room and the chair could be tilted independent of one another. The subject was then asked to adjust his or her body to the upright position.

A field dependent individual would adjust his or her body to the surrounding tilted position of the room and reported that he or she was sitting in an upright position. On the other hand, a field dependent individual would adjust his or her body to a position that was independent of the tilted chair and the tilted room. The BAT has been found to be a valid and reliable instrument in assessing field dependence/field independence (Witkin, 1948; Witkin, 1949).

Another assessment of field dependence/field independence was developed by Witkin, Dyk, Faterson, Goodenough, and Karp (1974). This test was called the Rod and Frame Test (RFT). In administering the Rod and Frame Test (RFT), a subject was seated in a darkened room and shown a luminous rod situated within a luminous frame. The rod and the frame could be tilted independently, and the subject was asked to adjust the rod to the true vertical position as the frame was tilted.

A field dependent individual, strongly influenced by the frame, would not rotate the rod to a vertical position. A field independent individual would adjust the rod the true vertical position. The RFT was also found to be a valid (Witkin, 1948; Witkin & Asch,
1948) and reliable (Witkin, 1948; Witkin & Asch, 1948; Oltman, 1964) instrument in testing for field dependence/field independence.

Paper and pencil tests have also been developed for assessing field dependence/field independence. The Embedded Figures Test (EFT) was developed for use with individuals (Witkin, Oltman, Raskin, & Karp, 1971). The Children’s Embedded Figures Test (CEFT) was developed for use with individual children between the ages of five (5) and ten (10) (Karp & Konstadt, 1971). The Group Embedded Figures Test (GEFT) was developed to be administered in a group setting (Oltman, Raskin, & Witkin, 1971).

The subjects’ task in the EFT, CEFT, and GEFT was to identify a previously seen simple figure that had been embedded within a larger complex figure. The ability to locate the simple figure within the complex figure indicated a field independent learning style, whereas the inability to locate the simple figure within the complex figure indicated a field dependent learning style. The EFT, CEFT, and GEFT were considered standardized tests and have been tested for validity and reliability (Garton, 1993; Witkin, Oltman, Raskin, & Karp, 1971).

Field dependent learners and field independent learners had very different styles in which they approached a learning experience (Cano, 1988; Cano, 1993; Claxton & Ralston, 1978; Ekstrom, 1976; Garger & Guild, 1984; Garton, 1993; Koppleman, 1980; Mahllos, 1981; Saracho, 1989; Torres, 1993; Witkin, 1976; Witkin et al., 1977a; Witkin et al., 1977b). In addition, it must be restated that there should be no assumptions that there were only two distinct types of learners, field dependent and field independent (Claxton & Murrell, 1987; Claxton & Ralston, 1978; Witkin, Moore, Goodenough, & Cox, 1977a). Furthermore, it must also be realized that one learning style was not superior to another (Witkin et al.,
1977a). The characteristics and behaviors to follow sought to describe field dependent and field independent learners on each extreme of the bipolar continuum.

**Characteristics and Behaviors of Field Dependent Learners**

Field dependent learners, those individuals that were heavily influenced by the surrounding field, perceived the world globally (Reiff, 1992). In addition, field dependent learners found it more difficult to solve a multi-step learning task. Therefore, field dependent learners attempted to break up multi-step tasks, and upon being unable to do so, became quickly frustrated (Cano, 1993; Garton, 1993; Witkin et al., 1977a; Witkin et al., 1977b). When dependent learners experienced difficulty in breaking down a task and became frustrated, field dependent learners tended to give up quickly and became uninterested (Cano, 1993; Torres, 1993). Due to the inability of dependent learners in breaking down tasks, field dependents were considered to be poor analytical problem solvers (Cano, 1993; Garton, 1993; Torres, 1993; Witkin et al., 1977a, Witkin et al., 1977b).

In regard to social environments, Torres (1993) indicated that social contexts and orientations were preferred by field dependent learners. In addition, Witkin et al. (1977a) claimed that field dependent learners were “selectively attuned to social components of the environment” (p. 10). Furthermore, Holley (1972), and Witkin et al. (1977a), indicated that field dependent learners were drawn to others, in the sense of liking to be with people. Weissenberg and Gruenfeld (1966) claimed that others perceived field dependent learners as warm, tactful, considerate, socially outgoing, and affectionate. In the learning environment, Cano (1993) reported that field dependent learners would rather socialize with their peers, as opposed to becoming actively engaged in the learning process. Finally, due
to their strong need for socialization, field dependent learners preferred to work in small groups and take part in classroom discussion (Cano, 1993; Ekstrom, 1976; Witkin, 1976). Field dependent learners seemed to be responsive to extrinsic motivation due to their instinct for socialization (Cano, 1993). Field dependent learners sought guidance and rewards from the instructor, such as verbal praise (Cano, 1993; Garger & Guild, 1984; Garton, 1993; Reiff, 1992; Saracho, 1989; Torres, 1993; Witkin, 1976; Witkin et al., 1977a). Furthermore, dependent learners required externally defined goals and reinforcement, must be provided with organization in the teaching and learning process, and were highly sensitive to criticism (Cano, 1993; Garger & Guild, 1984; Witkin et al., 1977a).

**Characteristics and Behaviors of Field Independent Learners**

In contrast, field independent learners tended to have characteristics that were direct opposites of field dependent learners (Cano, 1993; Garton, 1993; Torres, 1993). Field independent learners, individuals that were not heavily influenced by the surrounding field, tended to perceive analytically (Cano, 1993; Garger & Guild, 1984; Garton, 1993; Reiff, 1992; Torres, 1993; Witkin, 1976; Witkin et al., 1977a; Witkin et al., 1977b). Field independent learners had a well developed perception of discrete parts and were able to separate discrete parts of a picture from the whole picture (Witkin et al., 1977a, Witkin et al., 1977b). Because of their ability to separate discrete parts, field independent learners found it easier to accomplish tasks that involved several steps, when compared to field dependent learners (Cano, 1993; Witkin, 1976; Witkin et al., 1977a). Furthermore, because of their analytical thinking ability, field independent learners were more adapted to problem solving tasks than field dependent learners (Even, 1982). Other researchers (Ronning, McCurdy, &
Ballinger, 1984; Witkin, 1976) agreed that individuals with a field independent learning style had an easier time with problem solving tasks, especially in the solving of mathematical and science based problems. Furthermore, Calkins and Welkowitz (1984) concluded that there was moderate support indicating that field independent learners were better adapted at problem solving skills.

Unlike the social characteristics of dependent learners, many researchers (Cano, 1993; Garger & Guild, 1984; Witkin, 1976; Witkin et al., 1977a) claimed that independent learners generally were individualistic and insensitive to the needs of others. In addition, field independent learners preferred independent studies, and were reluctant to work in groups, which was consistent with their unwillingness to socialize (Cano, 1993). In learning environments, Witkin et al. (1977a) claimed that field independent learners were proficient in providing their own structure for a learning situation and preferred to work without guidance from the instructor. Furthermore, field independent learners had greater achievement on tasks that lacked a clear structure (Witkin et al., 1977a).

Unlike field dependent learners, field independent learners were intrinsically motivated. Because field independent learners were intrinsically motivated, they did not react to social reinforcement and were nonresponsive to positive reinforcement offered by instructors (Cano, 1993). Field independent learners were motivated intrinsically through competition, choice of activities, and freedom to design their own structure (Cano, 1993; Garger & Guild, 1984; Reiff, 1992; Witkin, 1976). Furthermore, field independent learners had self-defined goals, and were less effected by criticism than field dependent learners (Garger & Guild, 1984).
Relationships between Learning Style and Grade Level (Age)

Witkin, Oltman, Raskin, and Karp (1971) reported that there were clear age related changes in field dependence and field independence over the life span. Witkin, Goodenough, and Karp (1967) reported a continuous increase towards field independence between ages eight (8) through fifteen (15). After age fifteen (15), during the years of early adulthood, a leveling off occurred (Witkin et al., 1967). Witkin et al. (1967) claimed that during early adulthood, field dependence showed absolute stability. At some point between the ages of twenty-four (24) to thirty (30), the rate of change towards field dependence accelerated (Witkin et al., 1971). In studies of elderly individuals, a return to field dependence occurred (Comalli, 1965; Schwartz & Karp, 1967).

Cano (1998), in a study of 715 high school students, found a positive, low relationship ($r = .21$) between score on the Group Embedded Figures Test (GEFT) and age. Cano’s (1998) conclusion indicated that as grade level increased, GEFT score also increased.

In a study on senior students in the College of Agriculture at The Ohio State University, Torres (1993) found a negative and low relationship ($r = -.19$) between age and Group Embedded Figures Test (GEFT) scores. That is, as age increased, scores on the Group Embedded Figures Test (GEFT) decreased.

Relationships between Learning Style and Gender

Persistent gender differences have been found in the dimensions of field dependence and field independence by several researchers (Garger & Guild, 1984; Witkin, 1976; Claxton & Ralston, 1978; Reiff, 1992; Torres, 1993). Males tended to be more field independent than females (Bennett, 1956; Witt, 1955; Witkin et al., 1971). However, Witkin et al. (1971)
claimed that the preponderance of research indicated that learning style differences in gender
may not have been present before the age of eight (8) or in geriatric groups.

Many of the stereotypes of males and females were based on the assumption that the
two genders approached the task of thinking in very different ways (Lips, Myers, & Colwill,
1978). Lips, Myers, and Colwill (1978) reported that “it is widely held... that men are logical
and women are intuitive” (p. 153). Furthermore, Lips, Myers, and Colwill (1978) claimed
that a woman with a “head for figures” was very rare, and men were quickly frustrated and
bored when performing simple, repetitive tasks.

Torres (1993) found a significant and low positive relationship ($r_{pb} = .26$) between
gender and Group Embedded Figures Test (GEFT) scores. In the same study, Torres (1993)
found 71.2% of males possessed a field independent learning style, while 28.8% of males
possessed a field dependent learning style. Furthermore, Torres (1993) indicated that
approximately 50% of females were field independent, while approximately 50% of the
females were field dependent. Torres (1993) concluded that males preferred a field
independent learning style, whereas females preferred a more field dependent learning style.

In a study of 450 students and ninety-seven (97) faculty in the College of Agriculture
at the University of Florida, Rudd, Baker, and Hoover (1998) found that the majority of both
males and females were field independent. Rudd, Baker, and Hoover (1998) found that
59.2% of males were field independent, while 40.8% of males were field dependent. In
addition, 55.3% of females were field independent, while 44.7% of females were field
dependent.

Conversely, Cano (1998), in a study of 715 high school students, indicated that
females were more likely to have a higher GEFT score than males. The issue of females
being more field independent than males in Cano’s (1998) study was not supported by previous research (Shea, 1984; Torres, 1993; Witkin, 1973; Witkin, 1976).

Furthermore, Raven, Cano, Garton, and Shelhamer (1993) found similar results of gender and learning style in a sample of preservice teachers of agriculture in the states of Montana and Ohio. Raven, Cano, Garton, and Shelhamer (1993) found that 54.5% of male preservice teachers in Montana and fifty (50) percent of male preservice teachers in Ohio were field dependent, whereas 45.5% of male preservice teachers in Montana and fifty (50) percent of preservice teachers in Ohio were field independent. In the same study, an overwhelming percent of female preservice teachers were found to be field independent. Raven, Cano, Garton, and Shelhamer (1993) found that one-hundred (100) percent of female preservice teachers in Montana and 71.4 percent of preservice teachers in Ohio were field independent.

**Relationships between Learning Style and Cumulative Grade Point Average (CGPA)**

Several studies have concluded that academic achievement was influenced by learning style (Cohen, 1968; Cohen, 1969; Cross, 1977; Dunn, 1983a; Dunn, 1983b; Giannitti, 1989; Hodges, 1986; Krimsy, 1982; Kroon, 1985; Shea, 1984). Reichmann (1979) indicated that students’ learning style may be a better predictor of course success than demographic variables of students, such as physical stature, age, or sex. However, Witkin (1976) suggested that learning style should be considered an ingredient of intellect, and not a direct measure of intelligence or general cognitive competence.

Cohen (1968, 1969) and Cross (1977) indicated that field independent learners were often found to perform better in the school setting (Cohen, 1968; Cohen, 1969; Cross, 1977).
in addition, Hodges (1986) reported that learners who were identified as learners that preferred to work alone, a field independent characteristic, achieved significantly greater scores on tests than learners who preferred to work with their peers, a field dependent characteristic. Furthermore, field independent learners were also found to achieve greater scores on standardized measures of academic ability (Renninger & Snyder, 1983).

In regards to agricultural education, several studies (Cano, Garton, & Raven, 1992; Cano & Garton, 1992; Cano & Torres, 1994; Raven, Cano, & Shelhamer, 1993) found that field independent agricultural education students earned greater scores in their methods courses. In addition, Cano, Garton, and Raven (1992) found that field independent agricultural education students scored greater than field dependent agricultural education students on tests, assignments, and micro-teachings. Furthermore, Estadt (1997) concluded that agricultural education students who operated in a field independent mode of learning, had greater grade point averages upon graduating from college, than field dependent agricultural education students. In a study of senior students in the College of Agriculture at The Ohio State University, Torres (1993) found a significant, moderate, and positive relationship \( r = .34 \) between Cumulative Grade Point Average (CGPA) and Group Embedded Figures Test (GEFT) score.

Cano and Porter (1997), in a study of College of Agriculture students at The Ohio State University, also found relationships between learning style and CGPA. In 1995, there was a low, positive, and significant relationship \( r = .24 \) found between CGPA and learning style. In 1996, the relationship between learning style and CGPA was significant, moderate, and positive \( r = .30 \). The positive relationships indicated that as the score on the Group Embedded Figures Test (GEFT) increased, an increase in CGPA was also noted.
Learning Styles Summary

Learning style is a construct that plays an important role in the educational process. Researchers have defined and categorized the term in various ways. Kolb created the four step cyclical learning process (Figure 2.1, Figure 2.2). Gregorc concentrated on the dualities of abstract-concrete and sequential-random (Figure 2.3). Kenneth and Rita Dunn identified twenty-one (21) elements that affected learning style. Witkin (1976) focused his research on the bipolar dimensions of field dependence and field independence (Figure 2.4). It is imperative that it be recognized throughout education that each individual learner, though very similar to others in many respects, is very unique in regards to learning style.

Cognitive Abilities

Reviews of recent studies (Flores, 1995; Torres, 1993) that evaluated cognitive abilities eluded straightforward definitions of the term "cognitive abilities." Flores (1995) and Torres (1993) seemed to focus their efforts on theories of cognitive development, such as Piaget (1952), levels of cognition, such as Bloom's Taxonomy (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956), and cognitive levels of instruction (Cano, 1988; Miller, 1989; Pickford; 1988; Whittington, 1991) in explaining cognitive abilities. Despite the fact that cognitive development, levels of cognition, and cognitive levels of instruction were all relevant to explaining cognitive abilities, it was necessary to include some direct knowledge of the term "cognitive abilities" in this review of related literature as it was to be a variable within the present study.

The practice of avoiding the defining of what was meant by cognitive abilities was not unusual in reviewing the literature. Researchers were reluctant to define what was
implied by the construct "cognitive ability" because of its general nature. Instead, researchers used standardized tests, reported results, and drew conclusions about cognitive abilities. Therefore, the following has attempted to shed some insight on the rather abstract construct of cognitive ability.

**Origin of Cognitive Abilities**

"Cognitive psychology is the branch of psychology concerned with how people think, learn, and remember" (Halpern, 1992, p.9). The ability to think, learn, and remember was also related to the concept of intelligence (Halpern, 1992). However, the term intelligence was so general and encompassing that attempts at defining the word have been vague, insignificant, and meaningless. It was stated that the term intelligence was not a unitary construct (Caplan, Crawford, Hyde, & Richardson, 1997; Cattell, 1971; Halpern, 1992; Khalifa, 1994; Spearman, 1923; Wagman, 1996).

The major issue researchers, namely Thorndike, Binet, and Spearman, addressed in breaking down the broad term intelligence was, "How many unitary abilities exist ... in what can be designated semantically intelligence?" (Cattell, 1971, p. 7). Caplan et al. (1997) indicated that "there is no such thing as intelligence... rather, the term 'intelligence' is used by different people to refer to different clusters of abilities, aptitudes, or achievements" (p. 57). It was reported that intelligence was the "thing" measured with intelligence tests (Caplan et al., 1997; Halpern, 1992; Cattell, 1971; Khalifa, 1994; Wagman, 1996).

Researchers such as Thorndike (1931) and Thurstone and Thurstone (1941) utilized factor analysis to identify single underlying traits or influences of the general term "intelligence" (Caplan et al., 1997; Cattell, 1971; Halpern, 1992). Thorndike (1931) found
three (3) to four (4) main groupings of abilities, or "intelligences" (Cattell, 1971). Thurstone and Thurstone (1941), upon administering sixty (60) different ability tests to eighth (8th) grade students, found three (3) factors, or abilities, very similar to Thorndike's (1931). The abilities found by Thorndike (1931) and Thurstone and Thurstone (1941) were verbal, number or quantitative, and perceptual or spatial. Verbal abilities, quantitative abilities, and spatial abilities were then considered to be cognitive abilities and were "thought of as the 'underlying dimensions' of intelligence" (Halpern, 1992, p. 9). On the other hand, cognitive ability tests did not measure intelligence or what has been interpreted from intelligence test scores. Beggs and Muow (1989) clearly stated that assessments of cognitive abilities, as measured by the Developing Cognitive Abilities Test (DCAT) did not measure stable traits that were commonly interpreted from intelligence test scores. Further explanation of what cognitive ability tests actually measured is offered later.

**Cognitive Abilities Defined**

As with intelligence, researchers also lacked consensus in defining cognitive abilities. Cognitive abilities were stated as abstract constructs and not unitary (Caplan et al., 1997; Halpern, 1992). Often, lists of skills were offered instead of a concrete definition for the term. As a result of the lack of definitional clarity, researchers often developed tests based on what they believed the constructs should measure (Caplan et al., 1997).

"Underlying [cognitive] abilities are abstract constructs" (Halpern, 1992, p. 10). Abstract constructs were what was intended to be measured in cognitive ability tests. Cognitive ability tests were developed to assess the likelihood of an individual's ability to succeed at certain tasks in the future if the individual was given proper instruction, and if the
individual was motivated to learn and demonstrate the skills needed to perform the task (Halpern, 1992). Cognitive abilities can then be thought of as "the ability to benefit from instruction in a certain area" (Halpern, 1992, p. 11).

As was stated earlier, cognitive abilities tests were not developed to measure intelligence or achievement. However, it was naïve to think that cognitive ability and intelligence or achievement were not related in some way. Beggs and Mouw (1989) claimed that their cognitive abilities test was intended to assess those characteristics that could be altered in the school environment. Because of the nature of what ability tests measured, Beggs and Muow (1989), and Halpern (1992), suggested that the correlation between cognitive ability tests and achievement tests was high.

A pure measure of cognitive ability would separate how an individual did on a particular test, which was considered achievement, with what that individual could potentially do, which was considered ability. Halpern (1992) suggested that caution be used in drawing conclusions from ability tests due to the blurry distinction between ability and achievement.

The following will explain what was intended by each of the three commonly measured cognitive abilities. The three commonly measured cognitive abilities were: verbal abilities; mathematical or quantitative abilities; and, spatial abilities.

**Verbal Ability**

The construct of verbal ability is not a unitary concept (Caplan et al., 1997; Halpern, 1992). Verbal ability has been defined and operationalized in many different ways. The term verbal abilities applied to all components of language usage such as, word fluency,
grammar, spelling, reading, verbal analogies, vocabulary, and oral comprehension (Halpern, 1992). Furthermore, much confusion was presented in the literature in regards to verbal abilities. Not all researchers tested for similar verbal abilities, therefore generalizations across differing tests were made extremely difficult (Halpern, 1992).

The following list of what has been measured in tests of verbal abilities, is worthy in attaining an idea of how varied the range of verbal abilities were in tests. The concepts that have been measured in tests of verbal abilities included: vocabulary size; speed of reading; reading comprehension; ability to express an idea in the fewest possible words; ability to make a number of different words from a group of letters; frequency of initiating conversations; ability to memorize lists of unrelated words quickly; ability to read, write, understand, or speak a foreign language; understanding of analogies; creative writing; fluency; age when first word was spoken; age when making first sound; skill at playing word games such as Hangman; talking to self while performing certain tasks; following of instructions; use of incomplete sentences; use of "ahs" when speaking; ability to learn a code; skill at anagrams; use of plural noun formations; and, length of sentences (Caplan et al., 1997; Maccoby & Jacklin, 1974; Ho, 1987; Pepin, Beaulieu, Matte, & Leroux, 1985; Wabar, 1977; Wilkie & Eisdorfer, 1977).

With verbal abilities, as with quantitative abilities and spatial abilities, it was clear that scores on tests could be enhanced or impeded by several intervening factors. Also, just as with quantitative abilities and spatial abilities, there has never been a consensus of what should make up verbal abilities. Furthermore, definitional problems would not be a factor had verbal ability tests yielded consistent results, or at least measured the same abilities. However, this obviously was not the case.
Mathematical or Quantitative Ability

Mathematical ability or quantitative ability is an abstract construct. "In an important sense, there is no such thing as 'mathematical or quantitative ability" (Caplan et al., 1997). Different people tended to apply "mathematical or quantitative ability" to different kinds of things. Cattell (1971) indicated that mathematical or quantitative ability involved skills (accuracy and speed) in the basic processes of addition, multiplication, subtraction, and division, and the somewhat more complex procedures commonly superimposed on them. Caplan et al. (1997) indicated that some people defined mathematical abilities simply as the capacities to add, subtract, multiply, divide, and perform algebraic and geometric manipulations, while others said mathematical or quantitative abilities involved the capacity to perform such calculations rapidly.

Caplan et al. (1997) also stated that “others would say that accuracy was the main criterion and that speed was irrelevant or of little importance” (p. 60). Furthermore, Caplan et al. claimed that “some would say that mathematical or quantitative ability was the capacity for ‘mathematical reasoning,’ meaning the capacity to recognize which kinds of mathematical processes or formulae should be applied to solve a particular problem” (p. 60). Caplan et al. (1997) suggested that mathematical abilities be defined as "all of the abilities that are needed to succeed in school mathematics courses" (p. 64). Finally, Halpern (1992) stated that mathematical or quantitative ability was simply "an individual's ability to acquire mathematical concepts" (p. 12).
Spatial Ability

The abstract construct of spatial abilities was even harder to define than that of verbal abilities and mathematical or quantitative abilities. Spatial ability, much like other cognitive abilities, is not a unitary concept. There has been no clear-cut realm of activities in schools that has instructed learners in spatial abilities. Beggs and Mouw (1989) indicated that spatial abilities were typically not a formal part of the school curriculum as were reading and mathematics. Researchers indicated that some subjects such as geography, portions of architecture, auto repair, engineering, and visual arts required some contribution from spatial abilities (Caplan, 1997).

Due to the fact that spatial ability was not a unitary construct and encompassed a vast number of concepts, spatial ability has been variously defined. Linn and Peterson (1986) suggested that spatial abilities were comprised of three factors: spatial perception; mental rotation; and, spatial visualization. Pawlik (1966) indicated that spatial ability had to do with "the ability to imagine properly the movement of spatial displacement of a configuration or some of its parts" (p. 543).

Cattell (1971) stated that spatial thinking involved keeping orientations in mind and thinking in three dimensions. Beggs and Mouw (1989) indicated that objects and their characteristics, such as size, shape, dimension, and transformational properties constituted the subject matter assessed in the spatial abilities subtest of the Developing Cognitive Abilities Test (DCAT). Guilford (1947) defined spatial abilities as the ability to move, turn, twist, or rotate an object or objects and to recognize a new appearance or position after the prescribed manipulation has been performed.
French (1951) indicated that spatial ability was the ability to perceive spatial patterns accurately and to compare them with each other. Thurstone (1950) purported spatial ability as an ability to recognize the identity of an object when it was seen from different angles. Linn and Peterson (1985) stated that spatial ability "generally refers to a skill in representing, transforming, generating, and recalling symbolic, nonlinguistic information" (p. 1482). Lips, Myers, and Colwill (1978) reported that "spatial abilities are those that enable a person to locate an object in space, mentally rearrange objects, recognize shapes, and so on" (p. 156).

A plethora of abilities were encompassed by the definitions offered by researchers and theorists. Among abilities embedded within definitions of spatial abilities were: map reading; figuring out where in a room a sound originated from; imagining how a three-dimensional assembly of blocks would look like if it were turned a certain number of degrees; recalling a series of shapes previously seen but only allowed to touch them; and, figuring out the directional rotation of a series of gears (Caplan et al., 1997; Cooper & Shepard, 1973; French, 1951; Guilford, 1947; Harris, 1978; Harshman, Hampson, & Berenbaum, 1983; Lips, Myers, & Colwill, 1978; Maccoby & Jacklin, 1974; Thurstone, 1950).

Many difficulties have led to a great deal of confusion and have impeded a consensus about the term spatial abilities. Definitional problems have led to confusion and uncertainty when evaluating and reviewing evidence reported by the literature. The preceding section clearly supported the confusion and uncertainty alleged in the literature.
Relationship between Cognitive Abilities and Grade Level

Little literature was found regarding the relationship between cognitive abilities and grade level. However, studies have been conducted regarding the relationship between cognitive abilities and age. Therefore, the assumption regarding age and grade level must be restated when the relationship between cognitive abilities was sought. The assumed ages of students and their respective grade levels were: ninth (9th) graders were assumed to have been between the ages of fourteen (14) and fifteen (15); tenth (10th) graders were assumed to have been between the ages of fifteen (15) and sixteen (16); eleventh (11th) graders were assumed to have been between the ages of sixteen (16) and seventeen (17); and, twelfth (12th) graders were assumed to have been between the ages of seventeen (17) and eighteen (18).

It has been an established fact that the performance of normal children on cognitive tasks improved with age (Green, 1944). For example, the proficiency on given cognitive tasks has been shown to increase with chronological age (Green, 1944).

Garrett, Bryan, and Perl (1935) conducted a study that sought to find the relationship between mental organization and age with 250 children at ages nine (9), twelve (12), and fifteen (15). Garrett et al. (1935) found significant improvement on memory test between subjects of nine (9) and twelve (12), but no significant improvements were found between the ages of twelve (12) and fifteen (15).

Green (1944) found statistically significant increases with age in the mean scores of primary mental abilities of 126 subjects at ages eleven (11), thirteen (13), and fifteen (15). Green (1944) concluded that word fluency, reasoning, and verbal abilities exhibited the greatest increase with age, whereas space and memory abilities increased the least with age.
In a study of senior students in the College of Agriculture at The Ohio State University, Torres (1993) found a positive, negligible relationship ($r = .03$) between Basic Cognitive Abilities and age. In addition, Torres (1993) found a negative, but negligible, relationship ($r = -.02$) between Application Abilities and age. In regards to Critical Thinking Abilities, Torres (1993) found a negative, but negligible, relationship ($r = -.08$) between Critical Thinking Abilities and age.

In a different study among high school Home Economics students in Puerto Rico, Flores (1995) found somewhat differing results. Flores (1995) found a negative, negligible relationship ($r = -.01$) between Basic Cognitive Abilities and age. In addition, Flores (1995) found a negative, negligible relationship ($r = -.02$) between Application Abilities and age. Furthermore, in regards to Critical Thinking Abilities, Flores (1995) found a negative, low relationship ($r = -.22$) between Critical Thinking Abilities and age.

**Relationship between Cognitive Abilities and Gender**

It has been claimed that males and females differed from each other in every area of psychological functioning, especially cognition (Caplan, Crawford, Hyde, & Richardson, 1997). Drever (1952) defined cognition as “a general term covering all the various modes of knowing - perceiving, imagining, conceiving, judging, and reasoning” (p. 42).

The psychological research, when defending the claim that males and females differed in cognitive abilities, has focused on particular domains of cognitive functioning such as verbal, quantitative, and spatial abilities (Caplan et al., 1997). Maccoby and Jacklin (1974) supported the previous statement and stated that there was evidence for the existence of gender differences in three types of cognitive ability: verbal; quantitative; and, spatial.
In general, females were reported to be superior to males in verbal ability, whereas males were found to be superior to females in quantitative ability and spatial ability.

**Verbal Abilities and Gender**

In regards to verbal abilities, it has been consistently reported that, on average, females were superior to males in verbal abilities (Caplan et al., 1997; Halpern, 1992; Lips & Colwill, 1978; Maccoby & Jacklin, 1974). Halpern (1992), and Maccoby and Jacklin (1974), indicated that males and females performed very similarly in verbal ability during childhood. However, Maccoby and Jacklin (1974) reported that gender differences in verbal abilities became very strong at about age ten (10), where females were found to surpass males. From age ten (10), through the high school and college years, Maccoby and Jacklin reported females outscored males at a variety of verbal skills.

Droegge (1967) conducted a longitudinal study of high school students and found that female dominance in verbal abilities increased through the high school period. Furthermore, females scored higher on tasks involving both receptive and productive language, and on high level verbal tasks (analogies, comprehension of difficult written material, and creative writing) as well as the lower level measures (fluency) (Maccoby & Jacklin, 1974). It was reported by Maccoby and Jacklin (1974) that the magnitude of female superiority in verbal abilities varied, however, the standard deviation of differences was most commonly approximately .25. In other words, the mean of the female distribution of scores was one-fourth of a standard deviation greater than the mean of the male distribution of scores.
Quantitative Abilities and Gender

Maccoby and Jacklin (1974) claimed that there were no apparent gender differences in quantitative ability during the preschool years or in the early school years. Furthermore, Lips, Myers, and Colwill (1978) reported that until early adolescence, the majority of students did not show any gender differences in quantitative abilities, however, males moved ahead after this point and showed consistently superior performance. In addition, Burnett, Lane, and Dratt (1979) reported that males tended to outscore females by approximately fifty (50) points on the quantitative portion of the SAT standardized test.

Developmental quantitative gender differences were assessed in a study of over 5,000 students aged thirteen (13) and seventeen (17). No gender differences were found in the sample of subjects at age thirteen (13), however, by the age of seventeen (17), the males were significantly outperforming the females (Jones, 1984).

It has been suggested that males were superior to females in quantitative abilities because males took more math courses (Lips, Myers, & Colwill, 1978). However, when students were matched on the number of math courses taken, males still showed greater scores (Flanagan, Dailey, Shaycoff, Gorham, Orr, Goldberg, & Neyman, 1961). The previous finding suggested that the tendency for males to outscore females in quantitative ability tests was not solely due to males’ higher level of training in mathematics (Lips, Myers, & Colwill, 1978; Maccoby & Jacklin, 1974).

The magnitude of gender differences in quantitative abilities varied greatly. However, Hyde (1981) suggested that the gender differences in quantitative differences was .45 standard deviation units. In other words, the mean of male distribution of scores on
quantitative abilities tests was .45 standard deviations greater than the female distribution of scores on quantitative abilities tests.

**Spatial Abilities and Gender**

McGee (1979) concluded that male superiority on tasks requiring spatial abilities was among the most persistent in all gender abilities. Linn and Peterson (1986) concluded that gender differences were apparent as soon as they could be measured reliably, suggested to be around age ten (10) or eleven (11). Maccoby and Jacklin (1974) reported that spatial ability gender differences were not present until adolescence. In general, differences in spatial ability favoring males was first detected around age seven (7), accelerated immensely around age eleven (11), but only reached statistically significant levels by age eighteen (18) (Halpern, 1992). Furthermore, evidence was found of a gender and age interaction such that spatial abilities declined more in older females than in older males, thus, magnifying the difference (Elias & Kinsbourne, 1974).

Male superiority in spatial abilities was consistently found in adolescence and adulthood (Maccoby & Jacklin, 1974). The male advantage in spatial abilities increased through the high school years, and has been measured with standard deviations of up to one (1), even though most measures of standard deviation were between .5 and .85 (Halpern, 1992; Linn & Peterson, 1986; Maccoby & Jacklin, 1974; Peterson & Crockett, 1985).

**Cognitive Ability Levels and Gender**

Torres (1993) concluded that gender differences were also present in terms of cognitive levels. Torres (1993) reported that males scored an average of 74.8% on Basic
Cognitive Abilities, while females scored an average of 71.9%. In addition, males scored an average of 77.4% on Application Abilities, whereas females scored an average of 71.5%. On the other hand, males scored an average of 61.9% on Critical Thinking Abilities, while females scored an average of 62.6%. Torres (1993) indicated, however, that no practical difference appeared to exist among genders in terms of cognitive levels.

In regards to relationships among cognitive levels and gender, Torres (1993), in a study of senior students at The Ohio State University, found a positive, negligible relationship \( r_{pb} = .10 \) between Basic Cognitive Ability and gender. As for Application Abilities, there existed a significant and positive relationship \( r_{pb} = .25 \) between Application Abilities and gender. Torres (1993) found a negative, negligible relationship \( r_{pb} = .02 \) between Critical Thinking Abilities and gender.

Flores (1995), in a study of high school Home Economics students, found a positive, low relationship \( r_{pb} = .29 \) between Basic Cognitive Abilities and gender. As for Application Abilities, Flores found a negative, negligible relationship \( r_{pb} = -.01 \) between Application Abilities and gender. Furthermore, a negative, low relationship \( r_{pb} = -.11 \) existed between Critical Thinking Abilities and gender (Flores, 1995).

**Relationships between Cognitive Abilities and Cumulative Grade Point Average (CGPA)**

Torres (1993) found a significant, substantial, and positive relationship \( r = .53 \) between Basic Cognitive Abilities and Cumulative Grade Point Average (CGPA). In addition, Torres (1993) found a significant, moderate, and positive relationship \( r = .49 \) between Application Abilities and CGPA. Furthermore, a significant, moderate, and positive relationship \( r = .33 \) was found between Critical Thinking Abilities and CGPA.
In another study, Flores (1995) found differing results. Flores found a negative, moderate relationship \( r = -.41 \) between Basic Cognitive Abilities and CGPA. Also, in regards to Application Abilities and CGPA, a negative, low relationship \( r = -.19 \) was found. Flores found a negative, negligible relationship \( r = -.04 \) between Critical Thinking Abilities and CGPA.

**Cognitive Abilities Summary**

It was reported in much of the literature that cognitive abilities were related, in a way, to intelligence (Caplan et al., 1997; Cattell, 1971; Halpern, 1992). However, it was made clearly evident that tests of cognitive abilities did not measure intelligence or what could be interpreted from intelligence test scores (Beggs & Mouw, 1989).

Throughout the literature, cognitive ability was very ill-defined, if defined at all. The three most studied cognitive abilities were verbal ability, mathematical or quantitative ability, and spatial ability. Verbal, mathematical or quantitative, and spatial abilities were also very ill-defined because they were very broad and general in nature, not unitary concepts, inconsistently interpreted among researchers, and because they were abstract constructs. It was emphasized throughout the literature that caution be utilized in making generalizations regarding cognitive abilities due to their definitional problems.

**Differences and Relationships between Learning Styles and Cognitive Abilities**

It has been argued that learning style may not be differentiable from cognitive abilities (Kogan, 1971). However, conceptually and historically, it has been claimed that
learning styles differed from cognitive abilities in a number of ways (Green, 1985; Messick, 1976, cited in Entwistle & Ramsden, 1983; Reiff, 1992).

Learning styles focused on the question of "how” learners processed information. For example, the manner in which a behavior occurred. Cognitive ability dimensions, on the other hand, essentially referred to the content of cognition, or the question of “what” was learned. For example, what kind of information was being processed, by what operation, and in what form (Messick, 1976, cited in Entwistle & Ramsden, 1983; Reiff, 1992)?

Furthermore, learning style was considered to be bipolar and value differentiated. That is, each pole had adaptive value depending upon the cognitive requirements of the task. An individual at one pole was no better or worse than another individual at the opposite pole (Green, 1985; Messick, 1976, cited in Entwistle & Ramsden, 1983; Reiff, 1992; Witkin, Moore, Oltman, Goodenough, Friedman, Owen & Raskin, 1977b). Cognitive abilities, however, were generally considered unipolar and value directional. Scales of measurement of cognitive abilities went from having little of an ability to having a lot of an ability. Therefore, having more of an ability was better than having less of an ability (Green, 1985; Messick, 1976, cited in Entwistle & Ramsden, 1983; Reiff, 1992).

Green (1985) claimed that learning styles and cognitive abilities also differed in regards to the environments in which the research was historically conducted. Historically, the concept of learning styles research has most often been in the psychological laboratory with the concept developing from personality theory. In contrast, Green (1985) reported that research with the concept of cognitive abilities was tied to education. However, recognizing that learning style research was traditionally conducted in the psychological laboratory
setting and not educationally, in more current research, the variable of time may have drastically changed the essence of where learning styles research has been conducted.

Furthermore, Green (1985) reported that learning styles exerted controls on mental functioning, whereas cognitive abilities did not. Learning styles cut across and were consistent with various task domains. However, cognitive abilities were specific to a particular domain of content or function.

Halpern (1992) claimed that cognitive abilities were "thought of as the 'underlying dimensions' of intelligence" (p. 9). In addition, Garton (1993) claimed “that although differences have been found between field independent and field dependent learning styles, the two remain independent of intelligence” (p. 65). Therefore, extrapolating on the claims of Halpern (1992) and Garton (1993), one could assume that learning styles and cognitive abilities were independent of one another. Furthermore, Witkin et al. (1977a) demonstrated that learning style was independent of intelligence, and thus “field dependence/field independence appears to be more related to the ‘how’ than to the ‘how much’ of cognitive function” (p. 24). Witkin (1976) and Reiff (1992) reported that field dependent learners and field independent learners had the same intellectual capacity, however, field independent learners had more cognitive flexibility than field dependent learners.

Federico and Landis (1980) reported that while learning style may have been correlated with cognitive abilities, the magnitude of the correlation was low. Because of the previous claim, Federico and Landis (1980) suggested that measures of learning style provided complementary, nonredundant information, meaning that measures of learning styles and measures of cognitive ability did not measure the same construct. However, when
measured simultaneously, measures of learning style and cognitive ability could provide valuable information on both constructs.

Torres (1993) found slightly contradictory results to Federico and Landis’ (1980) claim. Torres (1993) found a significant, positive, and moderate relationship (r = .47) between Basic Cognitive Abilities scores and Group Embedded Figures Test (GEFT) scores. In addition, Torres (1993) also found a significant, positive, and substantial relationship (r = .51) between Application Abilities and GEFT scores. Furthermore, a significant, positive, and moderate relationship (r = .36) existed between Critical Thinking scores and GEFT scores.

Summary of Chapter 2

Chapter 2 has discussed some of the established literature regarding learning style and cognitive ability. Learning style has proven to be an important construct in all of education. Some of the important researchers presented in Chapter 2 included Kolb, Gregorc, Kenneth and Rita Dunn, and Witkin. Kolb created the four step cyclical learning process (Figure 2.1, Figure 2.2). Gregorc reported learning style as dualities, such as abstract-concrete and sequential-random (Figure 2.3). Kenneth and Rita Dunn purported that there existed twenty-one (21) elements that effected learning style. Finally, Witkin researched the bipolar dimensions of field dependence and field independence in his research of learning style (Figure 2.4).

The middle portion of this review of related literature concentrated on cognitive ability. The three cognitive abilities most thoroughly and consistently studied were verbal ability, quantitative ability, and spatial ability. Verbal ability, quantitative ability, and spatial
ability were very ill-defined throughout the literature due to their broad scope, abstractness, and inconsistent interpretations among researchers. The most consistently reported relationship in cognitive abilities was in gender differences. Females were reported to be more superior in verbal ability, whereas males were reported to be superior in quantitative and spatial ability.

The final portion of this review of related literature dealt with the differences and relationships between learning style and cognitive ability. Even though relationships between learning style and cognitive ability have been identified, it has been reported that the two still differ in many ways.
CHAPTER 3
METHODOLOGY

The purpose of the study was to describe the learning style and cognitive abilities of students enrolled in Agricultural Education at Oak Harbor High School. Furthermore, the study sought to relate learning style and cognitive abilities to specific student characteristics. Chapter 3 discusses research design, population and sample, instrumentation, data collection, and data analysis.

Research Design

The study was descriptive and correlational in design. The aim of descriptive research, as indicated by Ary, Jacobs, and Razavieh (1985), was to describe and interpret what existed with respect to conditions or relationships among desired characteristics. Therefore, the study was designed to obtain information concerning students' learning styles and cognitive abilities. Two (2) standardized instruments were used for data collection. The Group Embedded Figures Test was used to collect information on learning style, and the Developing Cognitive Abilities Test, Level L, was used to collect information on cognitive abilities. Personological information was gathered through a brief information sheet, and to ensure accuracy, the selected student characteristics were gathered from school
administrative records. The information gathered was used to describe each characteristic of interest in detail and to accomplish the objectives of the study.

**Population and Sample**

The population of this study was students enrolled in Agricultural Education at Oak Harbor High School during the 1999-2000 academic year (N=153). Useable data was collected from 137 (n=137) students on April 12, 2000, yielding a 89.5% response rate. There were eleven (11) (7%) students absent and there were five (5) (3.5%) cases of unusable data. Data was deemed unusable by the researcher due to unreadable answer sheets or if the subject did not participate in all portions of the study. Students absent on the day of data collection were considered non-respondents. There was no further pursuit of data from non-respondents.

Error in measurement was addressed by controlling frame error, sampling error, selection error, and by using valid and reliable instruments. Frame error, sampling error, and selection error were controlled by collecting data from all Agricultural Education students in attendance on the data collection date. Furthermore, instruments which were valid and reliable were utilized in this study, thus minimizing measurement error.

**Instrumentation**

Two (2) standardized instruments and one (1) brief information sheet were utilized for data collection. The Group Embedded Figures Test (GEFT), developed by Oltman, Raskin, and Witkin (1971), was utilized to assess student learning style. The Developing Cognitive Abilities Test (DCAT), developed by Beggs and Mouw (1989), was utilized to
assess student cognitive abilities. One (1) level of the DCAT, Level L, was employed. A discussion of each of the instruments follows.

**Group Embedded Figures Test (GEFT)**

The GEFT was administered to all students enrolled in Agricultural Education at Oak Harbor High School and in attendance on April 12, 2000. The GEFT was administered following the guidelines provided in the *Manual: Embedded Figures Test, Children's Embedded Figures Test, Group Embedded Figures Test* (Witkin, Oltman, Raskin, & Karp, 1971).

The Group Embedded Figures Test, developed by Philip Oltman, Evelyn Raskin, and Herman Witkin (1971), was created for group settings from the Embedded Figures Test (EFT). The EFT, considered to be the parent test of the GEFT, was utilized to assess a student's learning style as field-dependent or field-independent, and was used in individual settings.

In the Group Embedded Figures Test, a subject's learning style, field dependent or field independent, was determined by their ability to disembend eighteen (18) simple figures from a more complex field. The GEFT was a timed test. The GEFT was developed to be used over a broad age range, beginning with age thirteen (13) and greater (Witkin, Oltman, Raskin, & Karp, 1971). Therefore, the GEFT was utilized across all four (4) grade levels to assess student learning style.

The GEFT contains three (3) sections. The first section was used primarily for practice. The first section contained seven (7) simple geometric figures. The subjects were
given two (2) minutes to complete the practice section. The first section was not utilized in assessing a GEFT score for the subject.

Section II and Section III each contained nine (9), more complex geometric figures. Subjects were given five (5) minutes to complete each of the two (2) sections. The task in Section II and Section III was synonymous to the first section. The subject was to trace a previously seen simple geometric figure embedded within a more complex figure. The more complex figure was designed such that the sought-after simple geometric figure was obscured and not easily identified. The ability to locate the simple geometric figure within the complex figure was a trait of field independent learners. The number of correctly identified simple figures in the eighteen (18) items of Section II and Section III comprised the portion of the test utilized in assessing an individual's learning style. Thus, an individual could score between zero (0) and eighteen (18), inclusively.

The eighteen (18) items in the two scorables sections, Section II and III, were scored, tallied, and utilized in assessing a subject's learning style. Each of the eighteen (18) items were evaluated as being either correct or incorrect. Subjects that achieved a score greater than the national mean of 11.4 were considered to be field independent, whereas subjects scoring less than the national mean of 11.4 were considered to be field dependent (Witkin, Oltman, Raskin, & Karp, 1971).

Validity of GEFT

The validity of the Group Embedded Figures Test has been established by determining its relationship with the Embedded Figures Test (EFT), Rod and Frame Test (RFT), and the Body Adjustment Test (BAT). The correlation coefficients between the
GEFT and the EFT were -.82 for males and -.63 for females (Witkin, Oltman, Raskin, & Karp, 1971). The negative correlation coefficients resulted from the tests being scored in reverse order.

Reliability of GEFT

The reliability of the GEFT has been determined to be .82 (Witkin et al., 1971). Correlation coefficients between the GEFT and the BAT were .71 for males, and .55 for females (Witkin et al., 1971). The correlation coefficients between the GEFT and the RFT were reported as -.39 for males, and -.34 for females (Witkin et al., 1971). The reported correlational coefficients were testimonial to the reliability and validity of the GEFT.

Developing Cognitive Abilities Test (DCAT)

The DCAT was administered to all Agricultural Education students attending Oak Harbor High School on April 12, 2000. Administration procedures, as outlined in the Directions for Administration: Levels E-L, Form 3 (Wick, 1990), were followed. Subjects were given fifteen (15) minutes to complete the Verbal subtest, twenty-five (25) minutes to complete the Quantitative subtest, and twenty (20) minutes to complete the Spatial subtest (Figure 3.1). For this study, the DCAT Level L, was utilized to assess cognitive abilities of all Agricultural Education students at Oak Harbor High School.

The Developing Cognitive Abilities Test (DCAT) was utilized as a measure of cognitive abilities. The DCAT was developed by Donald Beggs and John Mouw. The DCAT was developed for the assessment of specific abilities that were related to topics or
<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 minutes</td>
</tr>
<tr>
<td>Quantitative</td>
<td>27</td>
<td>25 minutes</td>
</tr>
<tr>
<td>Spatial</td>
<td>27</td>
<td>20 minutes</td>
</tr>
<tr>
<td>TOTAL</td>
<td>81</td>
<td>60 minutes</td>
</tr>
</tbody>
</table>

Figure 3.1: Subtests, Number of Items, and Time Limits for the DCAT, Level L

learning tasks taught in particular school subjects (Beggs & Mouw, 1989). Specifically, the DCAT was developed for the purpose of identifying the differential abilities among students in content areas and along cognitive levels of the cognitive taxonomy. The cognitive abilities assessed by the DCAT were believed to be abilities that could be modified through proper instructional techniques (Schwartz, 1986, cited in Beggs & Mouw, 1989).

The DCAT was intended to give an indication of cognitive characteristics that could be altered in a school environment (Beggs & Mouw, 1989). Therefore, correlations between the DCAT and achievement tests were high, however the DCAT was not intended to be utilized as an achievement test (Beggs & Mouw, 1989). The DCAT was comprised of a total of eighty-one (81) questions, further broken down into three (3) subtests (Verbal, Quantitative, and Spatial).

The Developing Cognitive Abilities Test was developed along a format which included both a cognitive taxonomy and a content area taxonomy (Beggs & Mouw, 1989). Therefore, the DCAT yielded test scores on two (2) dimensions: cognitive levels and specific content areas. The cognitive levels of the DCAT were consistent with the cognitive
domains purported by Bloom, Engelhart, Furst, Hill, and Krathwohl (1956), excluding the evaluation level of Bloom’s taxonomy (Bloom et al., 1956). The three (3) content areas in the DCAT were similar to those found in traditional ability tests; Verbal, Quantitative, and Spatial (Beggs & Mouw, 1989) (Figure 3.2).

<table>
<thead>
<tr>
<th>Bloom’s Levels of Cognition</th>
<th>DCAT Levels of Cognition</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>

Figure 3.2: Relationship between Bloom’s Taxonomy (Bloom et al., 1956) and the Developing Cognitive Abilities Test (Beggs & Mouw, 1989)

The three (3) cognitive levels included in the Developing Cognitive Abilities Test were Basic Cognitive Abilities, Application Abilities, and Critical Thinking Abilities. Five (5) cognitive levels of Bloom’s Taxonomy are included within the three (3) cognitive levels of the DCAT. The DCAT’s Basic Cognitive Abilities level measured cognitive taxonomic structures generally classified as knowledge and comprehension in Bloom’s taxonomy (Bloom et al., 1956; Beggs & Mouw, 1989). The Application Abilities items of the DCAT are generally associated with application items of Bloom’s Taxonomy (Bloom et al., 1956; Beggs & Mouw, 1989). The Critical Thinking abilities level of the DCAT includes items
generally classified as analysis and synthesis in Bloom’s Taxonomy (Bloom et al., 1956; Beggs & Mouw, 1989).

The subtests of the Developing Cognitive Abilities Test were Verbal, Quantitative, and Spatial. The verbal subtest was developed to measure the subjects literal understanding and use of words and phrases. The verbal subtest makes up one-third, or twenty-seven (27) questions, of the total content of the DCAT. The first portion of the verbal subtest was comprised of nine (9) questions. The first nine (9) questions of the verbal subtest were representative of a subject’s basic cognitive abilities, or comprehension and knowledge, in identifying meanings of words in the form of definitions, synonyms, or antonyms.

The second portion of the verbal subtest measured an individual’s application abilities and was represented by questions ten (10) through eighteen (18). Application abilities in the verbal subtest required the subject to appropriately use words and phrases in the construction of sentences. The verbal subtest’s final portion, questions nineteen (19) through twenty-seven (27), measured an individual’s critical thinking abilities. Critical thinking abilities in the verbal subtest involved perceiving interrelationships among a series of statements, making inferences from context, or forming conclusions through propositional reasoning about given information.

The quantitative subtest measured a subject’s ability to compute mathematical problems and contained a total of twenty-seven (27) questions. The first level of the quantitative subtest, questions one (1) through nine (9), measured a subject’s basic cognitive abilities. Basic cognitive abilities in the quantitative subtest involved the literal understanding of numerical relationships and required the functional understanding of the arithmetic operations of addition, subtraction, division, multiplication, and basic geometric
and trigonometric operations. Application abilities in the quantitative subtest of the DCAT involved traditional story problems, and was tested in questions ten (10) through eighteen (18). Application abilities in the quantitative subtest required the subject to perceive the mathematical relationships embedded in the logic of the problem, to retrieve the appropriate mathematical operation from memory, and to apply the principle to obtain the solution. Questions nineteen (19) through twenty-seven (27) required a subject to go beyond the application of a mathematical principle of a realistic problem and use critical thinking abilities. The Critical Thinking Abilities portion of the quantitative subtest required that a subject devise a pattern among mathematical relationships, and transform information to correctly solve the problem.

Spatial abilities were related to objects, their characteristics, shapes, and transformational properties. The Spatial Abilities subtest of the Developing Cognitive Abilities Test also contained twenty-seven (27) items. Basic cognitive abilities of the spatial subtest required a subject to recognize and retain characteristics of objects such as size, shape, symmetry, and pattern. Basic cognitive abilities in the spatial subtest were assessed in questions one (1) through nine (9). Tasks such as stacking boxes on shelves or understanding the consequences of the impact of two pool balls were utilized in the second portion of the spatial subtest, Application Abilities. Many of the items required the subject to identify outcomes of changing the arrangement or position of a real object. The application abilities of the spatial subtest were assessed in questions ten (10) through eighteen (18). Critical thinking abilities in the spatial subtest required the ability to transform and were evaluated in questions nineteen (19) through twenty-seven (27). Examples of tasks in the spatial critical thinking abilities portion of the test included
transformation of an object by folding, mentally rotating an object in space, or identifying the parts of an object after it has been divided.

**Validity of DCAT**

Many critical operations were involved in the development, standardization, and validation of the DCAT. A panel of experts was assembled in order to develop, standardize, and validate the DCAT. Among the various responsibilities of the panel of experts included those who analyzed curricula and instructional practices; those who reviewed, field tested, and selected items; and, those who scaled the DCAT (Wick, 1990).

**Reliability of DCAT**

The reliability of the DCAT was established by Beggs and Mouw as .81 for Basic Cognitive abilities, .76 for Application abilities, and .75 for Critical Thinking abilities. Overall, the reliability of the DCAT was established as .90 (Wick, 1990).

**Brief Information Sheet**

A brief information sheet was developed by the researcher to gather personological data from all students involved in the study. Data assessed by this instrument were gender, grade level, and cumulative grade point average (CGPA). In order to ensure accuracy of personological data, personological data were obtained from official high school records by the researcher.
Data Collection

Data for the study were collected in intact Agricultural Education classes at Oak Harbor High School. Two standardized instruments, the Group Embedded Figures Test (GEFT) and the Developing Cognitive Abilities Test (DCAT), Level L, were administered to 142 students. Data collection was completed during regularly scheduled Agricultural Education class times. The researcher and one (1) assistant administered the tests simultaneously in two (2) separate classrooms throughout the school day. The duration of four (4) of the data collection periods was eighty-seven (87) minutes, while one (1) data collection period was sixty (60) minutes in duration.

Two (2) intact classes of the sixty (60) minute data collection period were administered only the GEFT instrument on April 12, 2000. The subjects were then administered the DCAT on April 13, 2000, by the regular classroom instructor. It was necessary to administer only the GEFT on April 12, 2000, due to the reduced time allotted to the class. The class met daily for only sixty (60) minutes and both instruments could not be administered in the limited time. The total number of subjects that were studied in this manner was thirty (30).

A post-hoc analysis, independent sample t-test, was conducted to determine if the DCAT mean scores for the group of freshman students that were administered the instruments over two days were statistically the same as the DCAT mean scores for freshman students that were administered both the DCAT and the GEFT in the same day. The post-hoc analysis, independent sample t-test, concluded that the DCAT mean scores of the two different groups of freshman students were statistically the same (Table 3.1, Table 3.2).
Specific Content Area | mean n₁ | mean n₂ | t  | Significance |
-----------------------|---------|---------|----|--------------|
Verbal Ability         | 13.48   | 12.62   | .79| .44          |
Quantitative Ability   | 12.12   | 9.93    | 1.90| .06          |
Spatial Ability        | 9.84    | 9.07    | .80| .43          |

Table 3.1: Independent Sample T-Test Results: Comparison of Specific Content Area Mean Scores between Two Samples of Freshman Students (n₁ = 25) (n₂ = 29)

Level of Cognitive Ability | mean n₁ | mean n₂ | t  | Significance |
---------------------------|---------|---------|----|--------------|
Basic Cognitive Ability    | 11.88   | 11.79   | .08| .94          |
Application Ability        | 13.24   | 11.38   | 1.74| .09          |
Critical Thinking Ability  | 10.32   | 8.45    | 1.85| .07          |

Table 3.2: Independent Sample T-Test Results: Comparison of Level of Cognitive Ability Mean Scores between Two Samples of Freshman Students (n₁ = 25) (n₂ = 29)

The eighty-seven (87) minute data collection period was determined to be sufficient time to administer both the GEFT and the DCAT instruments. Eighty-seven (87) minutes was the normal span of time the students met in their established Agricultural Education classes. The GEFT required twenty (20) minutes for administration, while the DCAT required sixty (60) minutes for administration. The remaining seven (7) minutes were utilized for a brief introduction and time allotted to hand out instruments.

Subjects were first given a brief introduction. During the brief introduction, subject were assured of the strict confidentiality of the results of the study. Following the brief introduction, subjects were administered the GEFT. Upon completion of the GEFT, the subjects were allowed to take a brief break to stretch before the administration of the DCAT. Upon reconvening following the brief break, the DCAT was administered.
The researcher, and the assistant, administered the GEFT and the DCAT following the procedures specified in the GEFT and DCAT administration manuals (Manual: Embedded Figures Test, Children’s Embedded Figures Test, Group Embedded Figures Test, 1971; Directions for Administration: Levels E-L, Form 3, 1989) in all data collection periods. Furthermore, the two (2) classroom teachers administered the DCAT following the procedures specified in the DCAT administration manual (Directions for Administration: Levels E-L, Form 3, 1989) in the two (2) data collection periods that remained.

In order to ensure consistency among simultaneous classroom administration of the tests, the researcher provided the assistant and the two (2) classroom teachers with a script of instructions and explanations. The researcher, assistant, and the two (2) classroom teachers observed subjects during the administration of the instruments in order to address unacceptable behaviors. In addition, the researcher, assistant, and the two (2) classroom teachers were cautious not to engage in any behaviors that could have biased the data. There were no disruptive or unacceptable behaviors observed.

Of the 153 (N = 153) students enrolled in Agricultural Education at Oak Harbor High School, a total of 142 subjects participated in the study. Five (5) (3.5%) subjects’ data were deemed unusable, and therefore, were not analyzed for this study. Therefore, useable data was collected from 137 subjects (n=137), yielding a usable response rate of 89.5%. Subjects absent on the days of data collection were considered nonrespondents. There was no further effort to collect data on nonrespondents. Therefore, this study was only generalizable to those subjects present on the days of data collection.
Data Analysis

Raw scores were coded and entered into SPSS/PC+ (Statistical Package for the Social Science, Personal Computer) version 10.0 for Windows in order to apply statistical analysis operations. Descriptive and inferential statistics were utilized in analyzing data. The following identifies procedures utilized in order to arrive at values entered into the data set.

**Group Embedded Figures Test (GEFT)**

Each subject was required to respond to eighteen scorable items in the GEFT. Scores on the GEFT were hand scored by the researcher. The number correct was determined and entered as a raw score for each subject. The range of possible scores on the GEFT was zero (0) to eighteen (18).

**The Developing Cognitive Abilities Test (DCAT)**

The DCAT had three (3) content areas (Verbal, Quantitative, and Spatial), or subtests. Each of the three (3) subtests included items at three (3) levels of cognition (Basic Cognitive Abilities, Application Abilities, and Critical Thinking Abilities). Each subject was required to respond to the eighty-one (81) item DCAT. Twenty-seven (27) items of the DCAT fell under each of the three (3) content areas (Verbal, Quantitative, and Spatial). Nine (9) items in each of the three content areas were included in each of the three levels of cognition, making a total of twenty-seven (27) items falling under each of the three cognition levels (Figure 3.3).
<table>
<thead>
<tr>
<th>Cognitive Level</th>
<th>Verbal Abilities</th>
<th>Quantitative Abilities</th>
<th>Spatial Abilities</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Cognitive Abilities</td>
<td>Questions 1-9</td>
<td>Questions 1-9</td>
<td>Questions 1-9</td>
<td>27</td>
</tr>
<tr>
<td>Application Abilities</td>
<td>Questions 10-18</td>
<td>Questions 10-18</td>
<td>Questions 10-18</td>
<td>27</td>
</tr>
<tr>
<td>Critical Thinking Abilities</td>
<td>Questions 19-27</td>
<td>Questions 19-27</td>
<td>Questions 19-27</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>81</td>
</tr>
</tbody>
</table>

Figure 3.3: Item Structure for the Developing Cognitive Abilities Test

The total number of correct responses from each of the three (3) levels of cognition (Basic Cognitive Abilities, Application Abilities, and Critical Thinking Abilities) were hand scored by the researcher. The raw scores of each cognitive level were calculated and entered for each subject. The possible range of correct items for cognitive level scores was zero (0) to twenty-seven (27).

Since the DCAT was developed to yield scores on two (2) dimensions, raw scores in the three (3) content areas (Verbal, Quantitative, and Spatial) of the DCAT were also calculated for each subject. The raw scores for each of the three (3) content areas were entered. The possible range of correct items for content area scores was zero (0) to twenty-seventy (27).
Research Objectives' Analyses

The following explains the statistical operations applied in order to fulfill each of the research objectives of the study.

1. Describe students enrolled in Agricultural Education at Oak Harbor High School based on the following personological characteristics: grade level, gender, and cumulative grade point average (CGPA).

   Frequency, percentage, mean, and standard deviation were utilized to describe subjects’ grade level and cumulative grade point average (CGPA). Frequency and percentage were used to describe subjects’ gender.

2. Determine the learning style of students enrolled in Agricultural Education at Oak Harbor High School as measured by the Group Embedded Figures Test (GEFT).

   Frequency, and percentage were utilized to determine the learning style of the subjects.

3. Determine the level of cognitive abilities (Basic, Application, and Critical Thinking) of students enrolled in Agricultural Education at Oak Harbor High School as measured by the Developing Cognitive Abilities Test (DCAT), Level L.

   Percentage, mean, and standard deviation were utilized to describe subjects’ cognitive abilities of Basic Cognitive Abilities, Application Abilities, and Critical Thinking Abilities.

4. Determine the content area cognitive abilities (Verbal, Quantitative, and Spatial) of students enrolled in Agricultural Education at Oak Harbor High School as measured by the DCAT, Level L.

   Percentage, mean, and standard deviation were utilized in order to describe subjects’ cognitive abilities in the specific content areas of Verbal, Quantitative, and Spatial.
5. Describe the relationships between learning style utilizing the GEFT and levels of cognitive abilities (Basic, Application, and Critical Thinking) utilizing the DCAT, Level L, of students enrolled in Agricultural Education at Oak Harbor High School.

In order to describe the relationships between subjects’ levels of cognitive abilities (Basic, Application, and Critical Thinking) and learning style, Pearson product-moment correlational coefficients were utilized.

6. Describe the relationship between learning style utilizing the GEFT and content area cognitive abilities (Verbal, Quantitative, and Spatial) utilizing the DCAT, Level L, of students enrolled in Agricultural Education at Oak Harbor High School.

Pearson product-moment correlational coefficients were utilized to describe the relationships between subjects’ specific content area cognitive abilities (Verbal, Quantitative, and Spatial) and learning style.

7. Describe the relationship between learning style utilizing the GEFT and selected student characteristics (grade level, gender, cumulative grade point average) of students enrolled in Agricultural Education at Oak Harbor High School.

Pearson product-moment correlation coefficients were utilized to describe the relationship between subjects’ learning style and subjects’ grade level and cumulative grade point average. Point-biserial correlation coefficients were used to describe the relationship between subjects’ learning style and subjects’ gender. Dummy coding was used for nominal/categorical variables such as gender.

8. Describe the relationship between level of cognitive abilities (Basic, Application and Critical Thinking) utilizing the DCAT, Level L, and selected student characteristics
(grade level, gender, cumulative grade point average) of students enrolled in Agricultural Education at Oak Harbor High School.

Pearson product-moment correlational coefficients were utilized to describe the relationship between subjects’ level of cognitive ability (Basic, Application, and Critical Thinking) and subjects’ grade level and cumulative grade point average. Point-biserial correlation coefficients were used to describe the relationship between subjects’ level of cognitive abilities (Basic, Application, and Critical Thinking) and subjects’ gender. Dummy coding was used for nominal/categorical variables such as gender.

9. Describe the relationship between content area cognitive abilities (Verbal, Quantitative, and Spatial) utilizing the DCAT, Level L, and selected student characteristics (grade level, gender, cumulative grade point average) of students enrolled in Agricultural Education at Oak Harbor High School.

Pearson product-moment correlation coefficients were utilized to describe the relationship between subjects’ specific content area cognitive abilities (Verbal, Quantitative, and Spatial) and subjects’ grade level and cumulative grade point average. Point-biserial correlation coefficients were used to describe the relationship between subjects’ specific content area (Verbal, Quantitative, and Spatial) and subjects’ gender. Dummy coding was utilized for nominal/categorical variables such as gender.

An alpha level of .05 was set a priori. Davis’ (1971) (Figure 3.4) conventions were utilized to interpret the strength of relationships reported in the study.
<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>

Figure 3.4: Davis’ Correlation Descriptions (Davis, 1971)

**Summary of Chapter 3**

Chapter 3 contained descriptions and explanations of the research design, population and sample, instrumentation, data collection, and data analysis. The research design was descriptive and correlational. The population of this study was students enrolled in Agricultural Education at Oak Harbor High School during the 1999-2000, academic year (N=153). The usable sample of this study was 137 (n=137). Two (2) standardized instruments and one (1) brief information sheet were utilized for data collection purposes. Data collection for this study was performed in intact Agricultural Education classes at Oak Harbor High School. Finally, in order to perform statistical operations, data was entered into SPSS/PC+, version 10.0 for Windows.
CHAPTER 4

FINDINGS

The purpose of the study was to describe the learning style and cognitive abilities of students enrolled in Agricultural Education at Oak Harbor High School. Furthermore, the study sought to relate learning style and cognitive abilities to specific student characteristics. Chapter 4 contains the findings of the study.

The findings of the study were presented in the order of the objectives of the study. The contents of the ensuing chapter include: 1) Personological Data; 2) Students’ Learning Style; 3) Students’ Level of Cognitive Abilities; 4) Students’ Specific Content Area Cognitive Abilities; 5) Correlates of Students’ GEFT Scores and Levels of Cognitive Ability; 6) Correlates of Students’ GEFT Scores and Specific Content Area Cognitive Ability; 7) Correlates of Students’ GEFT Scores and Personological Data; 8) Correlates of Levels of Cognitive Ability and Personological Data; and, 9) Correlates of Students’ Specific Content Area Cognitive Ability and Personological Data.

Personological Data

Personological data were collected on 137 Oak Harbor High School Agricultural Education students. Personological data that were gathered included grade level, gender, and
cumulative grade point average. The ensuing results indicated the findings of the personological data.

The data indicated that 39.4% (54) of Oak Harbor High School Agricultural Education students were in the ninth (9th) grade. In addition, 26.3% (36) of Oak Harbor High School Agricultural Education Students were in the tenth (10th) grade. The percent of Agricultural Education students at Oak Harbor High School in the eleventh (11th) grade was found to be 16.1% (22). Likewise, the data indicated that 18.2% (25) of Agricultural Education students at Oak Harbor High School were in the twelfth (12th) grade (Table 4.1). Furthermore, a gender analysis showed that 32.1% (44) of Oak Harbor High School Agricultural Education students were female, whereas 67.9% (93) were male (Table 4.2).

<table>
<thead>
<tr>
<th>Grade</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>54</td>
<td>39.4</td>
</tr>
<tr>
<td>10</td>
<td>36</td>
<td>26.3</td>
</tr>
<tr>
<td>11</td>
<td>22</td>
<td>16.1</td>
</tr>
<tr>
<td>12</td>
<td>25</td>
<td>18.2</td>
</tr>
<tr>
<td>Total</td>
<td>137</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 4.1: Grade Level of Oak Harbor High School Agricultural Education Students (n= 137)

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>44</td>
<td>32.1</td>
</tr>
<tr>
<td>Male</td>
<td>93</td>
<td>67.9</td>
</tr>
<tr>
<td>Total</td>
<td>137</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 4.2: Gender of Oak Harbor High School Agricultural Education Students (n= 137)
Cumulative grade point averages of Agricultural Education students at Oak Harbor High School were accessed through school records. Oak Harbor High School Agricultural Education students had a mean cumulative grade point average of 2.73, with a standard deviation of .82. Further analysis of grade point average data indicated that 2.2% (3) of Oak Harbor High School Agricultural Education students had a cumulative grade point average of less than .99, 15.3% (21) had a cumulative grade point average between 1.00 and 1.99, 40.1% (55) had a cumulative grade point average between 2.00 and 2.99, 37.2% (51) had a cumulative grade point average between 3.00 and 3.99, and 5.1% (7) had a cumulative grade point average greater than 4.00 (Table 4.3).

<table>
<thead>
<tr>
<th>Grade Point Average</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ .99</td>
<td>3</td>
<td>2.2</td>
</tr>
<tr>
<td>1.00-1.99</td>
<td>21</td>
<td>15.3</td>
</tr>
<tr>
<td>2.00-2.99</td>
<td>55</td>
<td>40.1</td>
</tr>
<tr>
<td>3.00-3.99</td>
<td>51</td>
<td>37.2</td>
</tr>
<tr>
<td>≥ 4.00</td>
<td>7</td>
<td>5.1</td>
</tr>
<tr>
<td>Total</td>
<td>137</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Mean = 2.73
Standard Deviation = .82

Table 4.3: Cumulative Grade Point Averages of Oak Harbor High School Agricultural Education Students (n= 137)

Students' Learning Style

The Group Embedded Figures Test (GEFT) was administered to 137 Oak Harbor High School Agricultural Education students in order to assess learning style. An individual’s learning style was determined based on the individual’s score on the GEFT. Learning style was dichotomized as being either field dependent or field independent. An
individual's learning style was considered to be field dependent if the individual's score on the GEFT was below the national mean of 11.4 (Witkin, Oltman, Raskin, & Karp, 1971). Furthermore, an individual's learning style was considered to be field independent if the individual's score on the GEFT was above the national mean of 11.4.

An analysis of 137 Oak Harbor High School Agricultural Education students' GEFT scores indicated that the mean GEFT score was 8.4 with a standard deviation of 4.82 (Table 4.4). Furthermore, the majority, or 67.9% (93), of Oak Harbor High School Agricultural Education students were field dependent learners, whereas 32.1% (44) were field independent (Table 4.5).

**Students' Level of Cognitive Abilities**

The Developing Cognitive Abilities Test (DCAT), Level L, was administered to 137 Oak Harbor High School Agricultural Education students to assess level of cognitive abilities. The DCAT provided scores on three levels of cognitive abilities: Basic Cognitive Abilities; Application Abilities; and, Critical Thinking Abilities. The maximum possible score for each of the three levels of cognitive abilities (Basic Cognitive Abilities, Application Abilities, and Critical Thinking Abilities) was twenty-seven (27).

An analysis of Basic Cognitive Abilities scores of 137 Oak Harbor High School Agricultural Education students yielded a mean of 12.39 with a standard deviation of 3.88 (Table 4.6). An examination of Application Abilities scores of Oak Harbor High School Agricultural Education students yielded a mean of 13.26 with a standard deviation of 4.39 (Table 4.7). Furthermore, analysis of Critical Thinking Ability scores yielded a mean of 10.49 with a standard deviation of 3.8 (Table 4.8)
<table>
<thead>
<tr>
<th>GEFT Score</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
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Mean = 8.4  
Standard Deviation = 4.82

Table 4.4: Group Embedded Figures Test (GEFT) Scores of Oak Harbor High School Agricultural Education Students (n= 137)

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Table 4.5: Learning Style of Oak Harbor High School Agricultural Education Students (n= 137)
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<th>Basic Cognitive Ability Score</th>
<th>Frequency</th>
<th>Percent (%)</th>
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Mean = 12.39  
Standard Deviation = 3.88

Table 4.6: Basic Cognitive Ability Scores of Oak Harbor High School Agricultural Education Students (n= 137)
<table>
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<th>Application Ability Score</th>
<th>Frequency</th>
<th>Percent (%)</th>
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Mean = 13.26
Standard Deviation = 4.39

Table 4.7: Application Ability Scores of Oak Harbor High School Agricultural Education Students (n=137)
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<tr>
<th>Critical Thinking Ability Score</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
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</table>

Mean = 10.49  
Standard Deviation = 3.8

Table 4.8: Critical Thinking Ability Scores of Oak Harbor High School Agricultural Education Students (n= 137)

Students’ Specific Content Area Cognitive Abilities

The Developing Cognitive Abilities Test (DCAT) also yielded scores based on three specific content area cognitive abilities. The three specific content areas were Verbal Ability, Quantitative Ability, and Spatial Ability. The maximum possible score on each of the three content areas (Verbal Ability, Quantitative Ability, and Spatial Ability) was twenty-seven (27).
An analysis of 137 Oak Harbor High School Agricultural Education students’ Verbal Ability yielded a mean of 13.91 with a standard deviation of 4.49 (Table 4.9). In addition, Oak Harbor High School Agricultural Education students’ Quantitative Ability was examined. Results of students’ Quantitative Ability yielded a mean of 12.19 with a standard deviation of 4.58 (Table 4.10). The mean score for 137 Oak Harbor High School Agricultural Education students’ Spatial Ability was found to be 10.10 with a standard deviation of 3.76 (Table 4.11).

<table>
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<th>Percent (%)</th>
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Mean = 13.91  
Standard Deviation = 4.49

Table 4.9: Verbal Ability Scores of Oak Harbor High School Agricultural Education Students (n= 137)
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Mean = 12.19  
Standard Deviation = 4.58

Table 4.10: Quantitative Ability Scores of Oak Harbor High School Agricultural Education Students (n= 137)
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<tr>
<td><strong>Total</strong></td>
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</table>

Mean = 10.10  
Standard Deviation = 3.76

Table 4.11: Spatial Ability of Oak Harbor High School Agricultural Education Students (n = 137)

Correlation between Group Embedded Figures Test (GEFT) Score and Levels of Cognitive Ability

Pearson product-moment correlation coefficients (r) were calculated to describe the relationship between Oak Harbor High School Agricultural Education students’ Group Embedded Figures Test (GEFT) score, and levels of cognitive ability (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability). Davis’ (1971) conventions were
utilized to interpret the magnitude of the relationships described. Correlations were based on the sample size of 137 (n= 137).

A significant, positive, and moderate relationship \((r = .46)\) was found between Group Embedded Figures Test (GEFT) score and Basic Cognitive Ability. In addition, a significant, positive, and substantial relationship \((r = .57)\) was found between GEFT score and Application Ability. Furthermore, a significant, positive, and moderate relationship \((r = .42)\) was found between GEFT score and Critical Thinking Ability (Table 4.12).

<table>
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<th>Variable</th>
<th>Basic Cognitive Ability</th>
<th>Application Ability</th>
<th>Critical Thinking Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEFT</td>
<td>.46*</td>
<td>.57*</td>
<td>.42*</td>
</tr>
</tbody>
</table>

\*\(p<.05\)

Table 4.12: Relationship between Group Embedded Figures Test (GEFT) Score and Levels of Cognitive Ability of Oak Harbor High School Agricultural Education Students (n= 137)

Correlation between Group Embedded Figures Test (GEFT) Score and Content Area Cognitive Ability

Pearson product-moment correlation coefficients \((r)\) were calculated to describe the relationship between Oak Harbor High School Agricultural Education students’ Group Embedded Figures Test (GEFT) score, and specific content area cognitive ability (Verbal, Quantitative, and Spatial). Davis’ (1971) conventions were utilized to interpret the magnitude of the relationships described. Correlations were based on the sample size of 137 (n= 137).

An analysis of the relationship between Group Embedded Figures Test (GEFT) score and Verbal Ability yielded a significant, positive, and moderate relationship \((r = .37)\). A
significant, positive, and moderate relationship \( (r = .47) \) was also found between GEFT score and Quantitative Ability. Furthermore, a significant, positive, and substantial relationship \( (r = .56) \) was found between GEFT score and Spatial Ability (Table 4.13).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Verbal Ability</th>
<th>Quantitative Ability</th>
<th>Spatial Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEFT</td>
<td>.37*</td>
<td>.47*</td>
<td>.56*</td>
</tr>
</tbody>
</table>

*p< .05

Table 4.13: Relationship between Group Embedded Figures Test (GEFT) Score and Content Area Cognitive Ability of Oak Harbor High School Agricultural Education Students (n= 137)

Correlation between Group Embedded Figures Test (GEFT) Score and Grade Level, Cumulative Grade Point Average (CGPA), and Gender

Pearson product-moment correlation coefficients \( (r) \) were calculated to describe the relationship between Oak Harbor High School Agricultural Education students’ Group Embedded Figures Test (GEFT) score, and grade level and cumulative grade point average. A point-biserial correlation coefficient \( (r_{pb}) \) was calculated in order to describe the relationship between GEFT score and gender. Davis’ (1971) conventions were utilized to interpret the magnitude of the relationships described. Correlations were based on the sample size of 137 (n= 137).

A positive and negligible relationship \( (r = .07) \) was found between Group Embedded Figures Test (GEFT) score and grade level. In addition, a significant, positive, and moderate relationship \( (r = .31) \) was found between GEFT score and cumulative grade point average.
Furthermore, a negative and low relationship ($r_{pb} = -.12$) was found between GEFT score and gender (Table 4.14).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Grade Level</th>
<th>Cumulative Grade Point Average</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEFT</td>
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<td>.31*</td>
<td>-.12</td>
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*p < .05

Table 4.14: Relationship between Group Embedded Figures Test (GEFT) Score and Grade Level, Cumulative Grade Point Average (CGPA), and Gender of Oak Harbor High School Agricultural Education Students (n = 137)

Correlation between Levels of Cognitive Ability (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability) and Grade Level, Cumulative Grade Point Average (CGPA), and Gender

Pearson product-moment correlation coefficients ($r$) were calculated to describe the relationship between Oak Harbor High School Agricultural Education students’ level of cognitive ability (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability), as measured by the Developing Cognitive Abilities Test (DCAT), Level L, and grade level and cumulative grade point average. A point-biserial correlation coefficient ($r_{pb}$) was calculated to describe the relationship between levels of cognitive ability (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability) and gender. Davis’ (1971) conventions were utilized to interpret the magnitude of the relationships described. Correlations were based on the sample size of 137 (n = 137).

An analysis of the correlation between Basic Cognitive Ability and grade level revealed a significant, positive, and low relationship ($r = .17$). A significant, positive, and
low relationship (r = .26) was also found between Application Ability and grade level. In addition, a significant, positive, and low relationship (r = .19) was found between Critical Thinking Ability and grade level (Table 4.15).

Analysis of the correlation between Basic Cognitive Ability and cumulative grade point average yielded a significant, positive, and moderate relationship (r = .33). The relationship between Application Ability and cumulative grade point average was also found to be significant, positive, and moderate (r = .33). The relationship between Critical Thinking Ability and cumulative grade point average was significant, positive, and low (r = .29) (Table 4.15).

Point-biserial correlation coefficients were calculated to describe the relationship between levels of cognitive ability (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability) and gender. The relationship between Basic Cognitive Ability and gender was found to be significant, negative, and low (r<sub>pb</sub> = -.28). In addition, a significant, negative, and low relationship (r<sub>pb</sub> = -.29) was found between Application Ability and gender. Furthermore, a significant, negative, and low relationship (r<sub>pb</sub> = -.21) was also found between Critical Thinking Ability and gender (Table 4.15).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Grade Level</th>
<th>Cumulative Grade Point Average</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Cognitive Ability</td>
<td>.17*</td>
<td>.33*</td>
<td>-.28*</td>
</tr>
<tr>
<td>Application Ability</td>
<td>.26*</td>
<td>.33*</td>
<td>-.29*</td>
</tr>
<tr>
<td>Critical Thinking Ability</td>
<td>.19*</td>
<td>.29*</td>
<td>-.21*</td>
</tr>
</tbody>
</table>

* p< .05

Table 4.15: Relationship between Levels of Cognitive Ability and Grade Level, Cumulative Grade Point Average (CGPA), and Gender (n= 137)
Correlation between Content Area Cognitive Ability and Grade Level, Cumulative Grade Point Average (CGPA), and Gender

Pearson product-moment correlation coefficients (r) were calculated to describe the relationship between Oak Harbor High School Agricultural Education students’ content area cognitive ability (Verbal Ability, Quantitative Ability, and Spatial Ability), as measured by the Developing Cognitive Abilities Test (DCAT), Level L, and grade level and cumulative grade point average. Point-biserial correlation coefficients (r_{pb}) were calculated to describe the relationship between content area cognitive ability (Verbal Ability, Quantitative Ability, and Spatial Ability) and gender. Davis’ (1971) conventions were utilized to interpret the magnitude of the relationships described. Correlations were based on the sample size of 137 (n= 137).

A significant, positive, and low relationship (r = .24) was found between Verbal Ability and grade level. A significant, positive, and low relationship (r = .18) was also found between Quantitative Ability and grade level. A positive and low relationship (r = .14) was found between Spatial Ability and grade level (Table 4.16).

Analysis of the relationship between Verbal Ability and cumulative grade point average identified a significant, positive, and low relationship (r = .25). A significant, positive, and moderate relationship (r = .40) was found between Quantitative Ability and cumulative grade point average. The relationship between Spatial Ability and cumulative grade point average was found to be significant, positive, and low (r = .25) (Table 4.16).

Point-biserial correlation coefficients were calculated in order to describe the relationship between content area cognitive ability (Verbal Ability, Quantitative Ability, and Spatial Ability) and gender. A significant, negative, and moderate relationship (r_{pb} = -.41)
was found between Verbal Ability and gender. A negative and low relationship ($r_{pb} = -.17$) was found between Quantitative Ability and gender. A negative and low relationship ($r_{pb} = -.12$) was also found between Spatial Ability and gender (Table 4.16).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Grade Level</th>
<th>Cumulative Grade Point Average</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal Ability</td>
<td>.24*</td>
<td>.25*</td>
<td>-.41*</td>
</tr>
<tr>
<td>Quantitative Ability</td>
<td>.18*</td>
<td>.40*</td>
<td>-.17</td>
</tr>
<tr>
<td>Spatial Ability</td>
<td>.14</td>
<td>.25*</td>
<td>-.12</td>
</tr>
</tbody>
</table>

*p< .05

Table 4.16: Relationship between Content Area Cognitive Ability and Grade Level, Cumulative Grade Point Average (CGPA), and Gender of Oak Harbor High School Agricultural Education Students (n= 137)
CHAPTER 5
SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Summary

Purpose of the Study

The purpose of the study was to describe the learning style and cognitive abilities of students enrolled in Agricultural Education at Oak Harbor High School. Furthermore, the study sought to relate learning style and cognitive abilities to specific student characteristics.

Research Objectives

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

1. Describe students enrolled in Agricultural Education at Oak Harbor High School based on the following personality characteristics: grade level, gender, and cumulative grade point average (CGPA).

2. Determine the learning style of students enrolled in Agricultural Education at Oak Harbor High School as measured by the Group Embedded Figures Test (GEFT).

3. Determine the level of cognitive abilities (Basic, Application, and Critical Thinking) of students enrolled in Agricultural Education at Oak Harbor High School as measured by the Developing Cognitive Abilities Test (DCAT), Level L.
4. Determine the content area cognitive abilities (Verbal, Quantitative, and Spatial) of students enrolled in Agricultural Education at Oak Harbor High School as measured by the DCAT, Level L.

5. Describe the relationships between learning style utilizing the GEFT and levels of cognitive abilities (Basic, Application, and Critical Thinking) utilizing the DCAT, Level L, of students enrolled in Agricultural Education at Oak Harbor High School.

6. Describe the relationship between learning style utilizing the GEFT and content area cognitive abilities (Verbal, Quantitative, and Spatial) utilizing the DCAT, Level L, of students enrolled in Agricultural Education at Oak Harbor High School.

7. Describe the relationship between learning style utilizing the GEFT and selected student characteristics (grade level, gender, cumulative grade point average) of students enrolled in Agricultural Education at Oak Harbor High School.

8. Describe the relationship between level of cognitive abilities (Basic, Application and Critical Thinking) utilizing the DCAT, Level L, and selected student characteristics (grade level, gender, cumulative grade point average) of students enrolled in Agricultural Education at Oak Harbor High School.

9. Describe the relationship between content area cognitive abilities (Verbal, Quantitative, and Spatial) utilizing the DCAT, Level L, and selected student characteristics (grade level, gender, cumulative grade point average) of students enrolled in Agricultural Education at Oak Harbor High School.
Research Design

The study was descriptive and correlational in design. The aim of descriptive research, as indicated by Ary, Jacobs, and Razavieh (1985), was to describe and interpret what existed with respect to conditions or relationships among desired characteristics. Therefore, the study was designed to obtain information concerning students' learning styles and cognitive abilities. Two (2) standardized instruments were used for data collection. The Group Embedded Figures Test was used to collect information on learning style, and the Developing Cognitive Abilities Test, Level L, was used to collect information on cognitive abilities. Personological information was gathered through a brief information sheet, and to ensure accuracy, the selected student characteristics were gathered from school administrative records. The information gathered was used to describe each characteristic of interest in detail and to accomplish the objectives of the study.

Population and Sample

The population of the study was students enrolled in Agricultural Education at Oak Harbor High School during the 1999-2000 academic year (N=153). Useable data was collected from 137 (n=137) students on April 12, 2000, yielding a 89.5% response rate. There were eleven (11) (7%) students absent and there were five (5) (3.5%) cases of unusable data. Data was deemed unusable by the researcher due to unreadable answer sheets or if the subject did not participate in all portions of the study. Students absent on the day of data collection were considered non-respondents. There was no further pursuit of data from non-respondents.
Instrumentation and Data Collection

Two (2) standardized instruments and one (1) brief information sheet were utilized for data collection. The Group Embedded Figures Test (GEFT), developed by Oltman, Raskin, and Witkin (1971), was utilized to assess student learning style. The Developing Cognitive Abilities Test (DCAT), developed by Beggs and Mouw (1989), was utilized to assess student cognitive abilities. One (1) level of the DCAT, Level L, was employed. In addition, a brief information sheet was utilized to gather personological data (gender, grade level, and cumulative grade point average) from Oak Harbor High School records.

Data for the study were collected in intact Agricultural Education classes at Oak Harbor High School. Two standardized instruments, the Group Embedded Figures Test (GEFT) and the Developing Cognitive Abilities Test (DCAT), Level L, were administered to 142 students. Data collection was completed during regularly scheduled Agricultural Education class times. The researcher and one (1) assistant administered the tests simultaneously in two (2) separate classrooms throughout the school day. The duration of four (4) of the data collection periods was eighty-seven (87) minutes, while one (1) data collection period was sixty (60) minutes in duration.

Two (2) intact classes of the sixty (60) minute data collection period were administered only the GEFT instrument on April 12, 2000. The subjects were then administered the DCAT on April 13, 2000, by the regular classroom instructor. It was necessary to administer only the GEFT on April 12, 2000, due to the reduced time allotted to the class. The class met daily for only sixty (60) minutes and both instruments could not be administered in the limited time. The total number of subjects that were studied in this manner was thirty (30).
An independent sample t-test was conducted to determine if the DCAT mean scores for the group of freshman students that were administered the instruments over two days were statistically the same as the DCAT mean scores for freshman students that were administered both the DCAT and the GEFT in the same day. The independent sample t-test concluded that the DCAT mean scores of the two different groups of freshman students were statistically the same.

Data Analysis

Raw scores were coded and entered into SPSS/PC+ (Statistical Package for the Social Science, Personal Computer) version 10.0 for Windows in order to apply statistical analysis operations. Descriptive and inferential statistics were utilized in analyzing data. Frequency distributions, percentages, means, and standard deviations were generated to address the objectives of the study. In addition, Pearson product-moment and point-biserial correlation coefficients were calculated to describe the relationships between variables. Davis’ (1971) conventions were utilized to describe the strength of relationships between variables. An alpha level of .05 was set a priori.

Summary of Findings

Personological Data

Personological data were collected on 137 Oak Harbor High School Agricultural Education students. Personological data that were gathered included grade level, gender, and cumulative grade point average. The ensuing results indicated the findings of the personological data.
The data indicated that 39.4% (54) of Oak Harbor High School Agricultural Education students were in the ninth (9th) grade. In addition, 26.3% (36) of Oak Harbor High School Agricultural Education Students were in the tenth (10th) grade. The percent of Agricultural Education students at Oak Harbor High School in the eleventh (11th) grade was found to be 16.1% (22). Likewise, the data indicated that 18.2% (25) of Agricultural Education students at Oak Harbor High School were in the twelfth (12th) grade. Furthermore, a gender analysis showed that 32.1% (44) of Oak Harbor High School Agricultural Education students were female, whereas 67.9% (93) were male.

Cumulative grade point averages of Agricultural Education students at Oak Harbor High School were accessed through school records. Oak Harbor High School Agricultural Education students had a mean cumulative grade point average of 2.73, with a standard deviation of .82. Further analysis of grade point average data indicated that 2.2% (3) of Oak Harbor High School Agricultural Education students had a cumulative grade point average of less than .99, 15.3% (21) had a cumulative grade point average between 1.00 and 1.99, 40.1% (55) had a cumulative grade point average between 2.00 and 2.99, 37.2% (51) had a cumulative grade point average between 3.00 and 3.99, and 5.1% (7) had a cumulative grade point average greater than 4.00.

Students’ Learning Style

The Group Embedded Figures Test (GEFT) was administered to 137 Oak Harbor High School Agricultural Education students in order to assess learning style. An individual’s learning style was determined based on the individual’s score on the GEFT. Learning style was dichotomized as being either field dependent or field independent. An
individual's learning style was considered to be field dependent if the individual's score on the GEFT was below the national mean of 11.4 (Witkin, Oltman, Raskin, & Karp, 1971). Furthermore, an individual's learning style was considered to be field independent if the individual's score on the GEFT was above the national mean of 11.4.

An analysis of 137 Oak Harbor High School Agricultural Education students’ GEFT scores indicated that the mean GEFT score was 8.4 with a standard deviation of 4.82. Furthermore, the majority, or 67.9% (93), of Oak Harbor High School Agricultural Education students were field dependent learners, whereas 32.1% (44) were field independent.

Students’ Level of Cognitive Abilities

The Developing Cognitive Abilities Test (DCAT), Level L, was administered to 137 Oak Harbor High School Agricultural Education students to assess level of cognitive abilities. The DCAT provided scores on three levels of cognitive abilities; Basic Cognitive Abilities, Application Abilities, and Critical Thinking Abilities. The maximum possible score for each of the three levels of cognitive abilities (Basic Cognitive Abilities, Application Abilities, and Critical Thinking Abilities) was twenty-seven (27).

An analysis of Basic Cognitive Abilities scores of 137 Oak Harbor High School Agricultural Education students yielded a mean of 12.39 with a standard deviation of 3.88. An examination of Application Abilities scores of Oak Harbor High School Agricultural Education students yielded a mean of 13.26 with a standard deviation of 4.39. Furthermore, analysis of Critical Thinking Ability scores yielded a mean of 10.49 with a standard deviation of 3.8.
Students’ Specific Content Area Cognitive Abilities

The Developing Cognitive Abilities Test (DCAT) also yielded scores based on three specific content area cognitive abilities. The three specific content areas were Verbal Ability, Quantitative Ability, and Spatial Ability. The maximum possible score on each of the three content areas (Verbal Ability, Quantitative Ability, and Spatial Ability) was twenty-seven (27).

An analysis of 137 Oak Harbor High School Agricultural Education students’ Verbal Ability yielded a mean of 13.91 with a standard deviation of 4.49. In addition, Oak Harbor High School Agricultural Education students’ Quantitative Ability was examined. Results of students’ Quantitative Ability yielded a mean of 12.19 with a standard deviation of 4.58. The mean score for 137 Oak Harbor High School Agricultural Education students’ Spatial Ability was found to be 10.10 with a standard deviation of 3.76.

Correlation between Group Embedded Figures Test (GEFT) Score and Levels of Cognitive Ability

Pearson product-moment correlation coefficients (r) were calculated to describe the relationship between Oak Harbor High School Agricultural Education students’ Group Embedded Figures Test (GEFT) score, and levels of cognitive ability (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability). Davis’ (1971) conventions were utilized to interpret the magnitude of the relationships described. Correlations were based on the sample size of 137 (n= 137).

A significant, positive, and moderate relationship (r = .46) was found between Group Embedded Figures Test (GEFT) score and Basic Cognitive Ability. In addition, a
significant, positive, and substantial relationship ($r = .57$) was found between GEFT score and Application Ability. Furthermore, a significant, positive, and moderate relationship ($r = .42$) was found between GEFT score and Critical Thinking Ability.

**Correlation between Group Embedded Figures Test (GEFT) Score and Content Area Cognitive Ability**

Pearson product-moment correlation coefficients ($r$) were calculated to describe the relationship between Oak Harbor High School Agricultural Education students’ Group Embedded Figures Test (GEFT) score, and specific content area cognitive ability (Verbal, Quantitative, and Spatial). Davis’ (1971) conventions were utilized to interpret the magnitude of the relationships described. Correlations were based on the sample size of 137 ($n=137$).

An analysis of the relationship between Group Embedded Figures Test (GEFT) score and Verbal Ability yielded a significant, positive, and moderate relationship ($r = .37$). A significant, positive, and moderate relationship ($r = .47$) was also found between GEFT score and Quantitative Ability. Furthermore, a significant, positive, and substantial relationship ($r = .56$) was found between GEFT score and Spatial Ability.

**Correlation between Group Embedded Figures Test (GEFT) Score and Grade Level, Cumulative Grade Point Average (CGPA), and Gender**

Pearson product-moment correlation coefficients ($r$) were calculated to describe the relationship between Oak Harbor High School Agricultural Education students’ Group Embedded Figures Test (GEFT) score, and grade level and cumulative grade point average.
A point-biserial correlation coefficient ($r_{pb}$) was calculated in order to describe the relationship between GEFT score and gender. Davis’ (1971) conventions were utilized to interpret the magnitude of the relationships described. Correlations were based on the sample size of 137 ($n=137$).

A positive and negligible relationship ($r = .07$) was found between Group Embedded Figures Test (GEFT) score and grade level. In addition, a significant, positive, and moderate relationship ($r = .31$) was found between GEFT score and cumulative grade point average. Furthermore, a negative and low relationship ($r_{pb} = -.12$) was found between GEFT score and gender.

**Correlation between Levels of Cognitive Ability (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability) and Grade Level, Cumulative Grade Point Average (CGPA), and Gender**

Pearson product-moment correlation coefficients ($r$) were calculated to describe the relationship between Oak Harbor High School Agricultural Education students’ level of cognitive ability (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability), as measured by the Developing Cognitive Abilities Test (DCAT), Level L, and grade level and cumulative grade point average. A point-biserial correlation coefficient ($r_{pb}$) was calculated to describe the relationship between levels of cognitive ability (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability) and gender. Davis’ (1971) conventions were utilized to interpret the magnitude of the relationships described. Correlations were based on the sample size of 137 ($n=137$).
An analysis of the correlation between Basic Cognitive Ability and grade level revealed a significant, positive, and low relationship ($r = .17$). A significant, positive, and low relationship ($r = .26$) was also found between Application Ability and grade level. In addition, a significant, positive, and low relationship ($r = .19$) was found between Critical Thinking Ability and grade level.

Analysis of the correlation between Basic Cognitive Ability and cumulative grade point average yielded a significant, positive, and moderate relationship ($r = .33$). The relationship between Application Ability and cumulative grade point average was also found to be significant, positive, and moderate ($r = .33$). The relationship between Critical Thinking Ability and cumulative grade point average was significant, positive, and low ($r = .29$).

Point-biserial correlation coefficients were calculated to describe the relationship between levels of cognitive ability (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability) and gender. The relationship between Basic Cognitive Ability and gender was found to be significant, negative, and low ($r_{pb} = -.28$). In addition, a significant, negative, and low relationship ($r_{pb} = -.29$) was found between Application Ability and gender. Furthermore, a significant, negative, and low relationship ($r_{pb} = -.21$) was also found between Critical Thinking Ability and gender.

Correlation between Content Area Cognitive Ability and Grade Level, Cumulative Grade Point Average (CGPA), and Gender

Pearson product-moment correlation coefficients ($r$) were calculated to describe the relationship between Oak Harbor High School Agricultural Education students’ content area cognitive ability (Verbal Ability, Quantitative Ability, and Spatial Ability), as measured by
the Developing Cognitive Abilities Test (DCAT), Level L, and grade level and cumulative grade point average. Point-biserial correlation coefficients ($r_{pb}$) were calculated to describe the relationship between content area cognitive ability (Verbal Ability, Quantitative Ability, and Spatial Ability) and gender. Davis' (1971) conventions were utilized to interpret the magnitude of the relationships described. Correlations were based on the sample size of 137 ($n=137$).

A significant, positive, and low relationship ($r = .24$) was found between Verbal Ability and grade level. A significant, positive, and low relationship ($r = .18$) was also found between Quantitative Ability and grade level. A positive and low relationship ($r = .14$) was found between Spatial Ability and grade level.

Analysis of the relationship between Verbal Ability and cumulative grade point average identified a significant, positive, and low relationship ($r = .25$). A significant, positive, and moderate relationship ($r = .40$) was found between Quantitative Ability and cumulative grade point average. The relationship between Spatial Ability and cumulative grade point average was found to be significant, positive, and low ($r = .25$).

Point-biserial correlation coefficients were calculated in order to describe the relationship between content area cognitive ability (Verbal Ability, Quantitative Ability, and Spatial Ability) and gender. A significant, negative, and moderate relationship ($r_{pb} = -.41$) was found between Verbal Ability and gender. A negative and low relationship ($r_{pb} = -.17$) was found between Quantitative Ability and gender. A negative and low relationship ($r_{pb} = -.12$) was also found between Spatial Ability and gender.
Conclusions

Based on the interpretation of the findings of the study, the following conclusions were drawn.

1. The largest groups of Oak Harbor High School Agricultural Education students were freshman and male. Furthermore, Oak Harbor High School Agricultural Education students had a mean cumulative grade point average of 2.73.

2. The majority of Oak Harbor High School Agricultural Education students were field dependent. The Group Embedded Figures Test (GEFT) mean score for Oak Harbor High School Agricultural Education students was 8.4 out of a possible eighteen (18).

3. Based on levels of cognitive ability mean scores, Oak Harbor High School Agricultural Education students scored highest on Application Ability and lowest on Critical Thinking Ability. Converting the cognitive ability level mean raw scores into percentages yielded a mean raw score of fifty (50) percent or less in all three cognitive ability levels. Furthermore, capacity for development was needed most in Critical Thinking Abilities.

4. Based on specific content area mean scores, Oak Harbor High School Agricultural Education students scored highest on Verbal Ability and lowest on Spatial Ability. Converting the content area mean raw scores into percentages yielded a mean raw score of fifty-one (51) percent or less in all three specific content areas. Furthermore, capacity for development was needed most in Spatial Abilities.

5. Oak Harbor High School Agricultural Education students that scored greater on the Group Embedded Figures Test (GEFT) tended to score greater on each of the three levels of cognitive abilities (Basic Cognitive Ability, Application Ability, and
Critical Thinking Ability) as measured by the Developing Cognitive Abilities Test (DCAT). That is, as an Oak Harbor High School Agricultural Education student’s score increased on the GEFT, the individual’s score on each of three levels of cognitive ability (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability), as measured by the DCAT, also tended to increase.

6. Oak Harbor High School Agricultural Education students that scored greater on the Group Embedded Figures Test (GEFT) tended to score greater on each of the three specific content area cognitive abilities (Verbal Ability, Quantitative Ability, and Spatial Ability) of the DCAT. That is, as an Oak Harbor High School Agricultural Education student’s score increased on the GEFT, the individual’s score on each of the three specific content area cognitive abilities (Verbal Ability, Quantitative Ability, and Verbal Ability), as measured by the DCAT, also tended to increase.

7. Of the three personological characteristics studied (gender, grade level, and cumulative grade point average), only cumulative grade point average was significantly related to the score on the Group Embedded Figures Test (GEFT). Furthermore, as cumulative grade point average of Oak Harbor High School Agricultural Education students increased, score on the GEFT tended to also increase.

8. Grade level, cumulative grade point average, and gender were all significantly related to each of the three levels of cognitive abilities (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability).
9. With the exception of Spatial Ability, personological data, such as grade level, cumulative grade point average, and gender, were all significantly related to content area cognitive abilities (Verbal Ability and Quantitative Ability).

Implications

Based on the results of the study, and the conclusions drawn, the following implications were developed.

1. Witkin et al. (1977b) reported a national mean GEFT score of 11.4. Individuals scoring greater than the national mean (11.4) on the GEFT were considered to be field independent. On the contrary, individuals scoring less than the national mean of 11.4 were considered to be field dependent (Witkin et al., 1971).

A mean score of 8.4 implied that Oak Harbor High School Agricultural Education students, as a whole, had a field dependent learning style. The variance (standard deviation = 4.82) indicated that the majority (68%) of the GEFT scores ranged from 3.6 to 13.2. The range of scores (3.6 - 13.2) implied that the majority of Oak Harbor High School Agricultural Education students ranged from a dominant field dependent learning style to a marginally field independent learning style.

Furthermore, the fact that the majority of Oak Harbor High School Agricultural Education students were field dependent implied that it was likely the students perceived the world globally. In addition, it could be implied that Oak Harbor High School Agricultural Education students, as a whole, were frustrated when forced to break down multi-step tasks, were poor analytical problem solvers, were extrinsically motivated, and preferred to work in group settings.
2. Beggs and Mouw (1989) indicated that results from the Developing Cognitive Abilities Test (DCAT) could be used to identify students’ strengths, weaknesses, and abilities that could be developed through instructional intervention. Converting the cognitive ability level mean scores into percentages yielded a mean of fifty (50) percent or less in all three cognitive ability levels. This would imply that, as a whole, Oak Harbor High School students have the capacity for improvement on Basic Cognitive Abilities, Application Abilities, and Critical Thinking Abilities through instructional intervention. Furthermore, it could be implied that the greatest need for cognitive development through instructional intervention was in Critical Thinking Ability.

3. Based on the conclusion that students’ mean score was less than fifty-one (51) percent on all three specific content areas implied that Oak Harbor Agricultural Education students, as a whole, have the capacity for improvement in Verbal Ability, Quantitative Ability, and Spatial Ability through instructional intervention. Furthermore, it could be implied that the greatest need for cognitive development through instructional intervention was in Spatial Ability.

4. The data implied that the Group Embedded Figures Test (GEFT) score was significantly related to all three levels of cognitive ability (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability). Furthermore, it could be implied that individuals that scored greater on the GEFT tended to score greater on the three levels of cognitive ability (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability).
5. The data implied that the Group Embedded Figures Test (GEFT) score was significantly related to all three specific content area cognitive abilities (Verbal Ability, Quantitative Ability, and Spatial Ability). Furthermore, it could be implied that individuals that scored greater on the GEFT tended to score greater on the three specific content area cognitive abilities (Verbal Ability, Quantitative Ability, and Spatial Ability).

6. Witkin et al. (1977b) indicated that GEFT score showed little association to cumulative grade point average, however, the current study negates Witkin et al.’s (1977b) claim. Furthermore, the data implied that Oak Harbor High School Agricultural Education students’ cumulative grade point average was significantly related to GEFT score. Similarly, the data implied that individuals with a higher cumulative grade point average tended to score greater on the GEFT.

7. Halpern (1992) and Pascarella (1985) indicated that student attributes such as grade level, cumulative grade point average, and gender should be considered as characteristics that could potentially influence cognitive ability. With respect to level of cognitive ability, the data of the current study supported Halpern’s (1992) and Pascarella’s (1985) claim. Furthermore, based on the data of the current study, it could be implied that grade level, cumulative grade point average, and gender were all significant predictors of level of cognitive ability (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability).

8. Halpern (1992) and Pascarella (1985) indicated that student attributes such as grade level, cumulative grade point average, and gender should be considered as characteristics that could potentially influence cognitive ability. With respect to
specific content area cognitive ability, excluding Spatial Ability, the data of the current study supported Halpern’s (1992) and Pascarella’s (1985) claim. Furthermore, based on the data of the current study, it could be implied that grade level, cumulative grade point average, and gender were significantly related to Verbal Ability and Quantitative Ability.

Recommendations

Recommendations for Instruction

1. Oak Harbor High School Agricultural Educators should strongly consider learning style preferences when planning and delivering instruction. In addition, instructors should have knowledge of students’ learning styles.

2. Oak Harbor High School should consider year-long themed workshops and inservices on learning style and cognitive ability based instruction. Workshops and inservices should be offered to instructors in order to enable teachers to identify specific learning styles and to conduct classroom instruction which would yield an increase in students’ cognitive development. Knowledge of students’ learning styles and cognitive ability could enable instructors to utilize their own teaching style strengths and develop diverse teaching strategies to facilitate and encourage success in learning.

2. Instructors should have an understanding of their own learning style. Cornett (1983) and Guild and Garger (1985) indicated that through a better understanding of learning style, teachers could reduce frustration for themselves and for their students. Furthermore, Reiff (1992) indicated that knowledge of learning style improved self-
concept, achievement, assisted in planning and management, increased variability and flexibility, and improved communication.

3. It is imperative for instructors and learners alike to value and accept diversity in learning styles. Understanding differences in learning style could then make way for improved learning and teaching. Therefore, teachers and counselors should educate learners on the differences in learning styles and assist learners in dealing with these differences.

4. Instructional intervention should occur to strengthen cognitive development at all three levels of cognitive ability at Oak Harbor High School (Basic Cognitive Ability, Application Ability, and Critical Thinking Ability). Agricultural Education instructors should place more emphasis on higher order thinking skills and include classroom activities requiring abilities in analysis and synthesis. In addition, tests and assignments assigned by instructors should include tasks requiring learners to utilize higher order thinking skills and higher levels of cognition. Furthermore, Oak Harbor High School agriculture instructors should provoke student involvement to stimulate student thinking at the higher levels of cognition.

5. Beggs and Mouv (1989) indicated that spatial skills were seemingly the least emphasized skills in schools and were typically not as much a part of the school curriculum as were reading (Verbal Ability) and arithmetic (Quantitative Ability). Therefore, instruction at Oak Harbor High School should occur that develops spatial skills, such as the recognition and retention of size, shape, symmetry, and pattern.
6. Oak Harbor High School Agricultural Educators should strongly consider student attributes, such as grade level, cumulative grade point average, and gender in planning and delivering instruction.

**Recommendations for Further Research**

1. The current study should be replicated in more than one school with Agricultural Education students throughout the state of Ohio.

2. The current study should be replicated with students in general education, as well as Agricultural Education, in order to study differences between the two groups.

3. Further research should assess learning styles of students, and learning styles of teachers, to study the impact of matching student’s learning style with the learning style of the instructor.

4. The current study should be replicated in other vocational programs.

5. The current study should be replicated with more personological data being assessed, such as score on other standardized tests (ie. American College Test, California Achievement Test) and personal career preferences (ie. post-secondary education, military, vocational).

6. Research should investigate if an instructor’s learning style is related to the level of cognition at which that instructor teaches.

7. Research should investigate if students who are taught to their preferred learning style, score greater on tests, homework, and quizzes than students who are not taught in their preferred learning style (Torres, 1993).
8. A longitudinal study should assess learners coming into high school as freshman, and also upon graduating from high school, in order to assess differences, if any, in learning style and cognitive ability during the four years in the high school.

9. Research should investigate levels of instruction students are receiving and assess if the level of instruction by an instructor leads to deficiencies in students’ cognitive ability.

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112


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122