AN ASSESSMENT OF THE COGNITIVE BEHAVIOR EXHIBITED BY SECONDARY AGRICULTURE TEACHERS

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Doctor of Philosophy

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by
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Have examined the dissertation entitled.

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To my loving wife Ann, I dedicate this work.

Thank you!

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AN ASSESSMENT OF THE COGNITIVE BEHAVIOR EXHIBITED

BY SECONDARY AGRICULTURE TEACHERS

Jonathan D. Ulmer

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ABSTRACT

Federal initiatives, state legislation, and educational leaders have encouraged educators to teach higher-order thinking skills. Teacher behaviors have been identified as variables of influence for higher-order thinking. The purpose of this study was to investigate the level of cognitive behavior exhibited by secondary agriculture teachers, how they compare to science teachers, and what characteristics are indicators of specific cognitive behaviors. The sample consisted of agriculture teachers in Central Missouri. Biology teachers from each school were utilized as a comparison group. For this descriptive-correlational study, the Florida Taxonomy of Cognitive Behaviors was used. Additionally, an attitudinal questionnaire was used to collect the teachers' attitude toward teaching at higher cognitive levels.

Agriculture teachers had a slightly favorable attitude toward teaching at higher cognitive levels. Eighty-two percent of agriculture teachers' observed class time was spent on lower-order behavior. Science teachers were found to have similar results. No differences were found between agriculture and science teachers' cognitive behaviors. Measures should be taken at both the in-service and pre-service level to inform teachers of the importance of cognitive behavior and techniques for exhibiting cognitive behavior. Teacher, school, and class characteristics did not predict cognitive behavior with the current data.

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CHAPTER I

INTRODUCTION

What is higher-order thinking? Why do we need higher-order thinking? Can higher-order thinking be taught? These are just a few of the questions that have perplexed educators in recent times. Lewis and Smith (1993) suggested that higher-order thinking requires a person to use new information or prior knowledge and manipulate the information to reach possible answers in new situations.

Newmann (1990) contrasted lower-order thinking and higher-order thinking. He stated, “Lower-order thinking demands only routine, mechanistic application of previously acquired knowledge…. In contrast, higher-order thinking challenges the student to interpret, analyze, or manipulate information” (p. 44).

Bloom (1956) identified a taxonomy for categorizing learning objectives, commonly referred to as Bloom’s Taxonomy. The taxonomy was split into six distinct cognitive levels: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. Knowledge and Comprehension are typically considered lower-order thinking with the other four levels being considered higher-order. Newmann (1990) asked “Why is higher-order thinking a desirable educational goal” (p. 45)? Answering his own question, Newmann asserted there were three reasons: (a) to be responsible and empowered citizens, (b) to contribute as productive workers, and (c) to manage one’s personal dealings, continue to learn and benefit from culture.

Higher-order thinking has been identified in several Federal initiatives and legislative actions as a goal of education (*A Nation at Risk, Goals 2000, Missouri*

Standards for Teacher Education, and *The Show-Me Standards*). Former Secretary of Education, T. H. Bell, charged the National Commission of Excellence in Education with the task of studying the American educational system. *A Nation at Risk: An Open Letter to the American People* (National Commission of Excellence in Education, 1983) was the result of their investigation. The findings were alarming to many in education. For instance, at the time, nearly 40% of 17-year-olds did not demonstrate higher-order thinking skills and could not draw inferences or conclusions from written material. Included with the findings were recommendations for improvement. Content recommendations included five core areas: English, mathematics, science, social studies, and computer science. Each of the five areas included educational goals that were content specific but also referred to higher-order thinking (i.e., the application of scientific knowledge to everyday life).

On March 31, 1993, *Goals 2000: Educate America Act* was signed by President William J. Clinton. *Goals 2000* established priorities for improving education and the participation of state and local communities (Department of Education, 1993). The Act was an attempt to reenergize community involvement with local schools. *Goals 2000* set eight national education goals to be achieved by 2000. The goals referred to "responsible citizenship, further learning, and productive employment" (p. 2).

Developed to improve teacher education and insure quality of students across the state, the Missouri Department of Elementary and Secondary Education (1999) created *The Missouri Standards for Teacher Education Programs* (MoSTEP). MoSTEP included eleven performance standards that all pre-service teachers were required to meet in order receive teacher licensure. Many of the standards related to higher-order thinking but one specifically listed higher-order skills: “The pre-service teacher uses a variety of instructional strategies to encourage students’ development of critical thinking, problem solving, and performance skills” (p. 2). According to Lewis and Smith (1993), problem solving, creative thinking, decision making, reasoning, and critical thinking are all encompassed under the term higher-order thinking. This standard emphasized the importance of teaching pre-service teachers to encourage the development of higher-order thinking skills.

The Missouri Department of Elementary and Secondary Education (1996) also developed *The Show-Me Standards*. The Standards were developed to help ensure Missouri high school graduates were learning the knowledge and skills necessary for a successful life. The belief that the success of Missouri students relies on their ability to apply knowledge and skills to the problems and experiences of life, was the foundation of the *Show-Me Standards*. Included were six content areas and four broad goals. Each goal included standards, of which many related to higher-order thinking (i.e., discover and evaluate patterns and relationships in information, ideas and structures).

Federal initiatives and state legislation are not the only groups that have called for developing higher-order thinking skills. John Dewey (1933), often considered to be one of the fathers of modern education, stated, “If thought is a distinct piece of mental machinery, separate from observation, memory, imagination, and common-sense judgments of persons, and things, then thought should be trained by special exercises designed for the purpose” (p. 55). According to Paul and Elder (2004b), unrefined thinking leads to bias and prejudice. Many problems in life can be attributed to poor thinking. When people are thoughtful at higher-levels of cognition they are motivated to act in a manner that helps themselves and others.

Within the agricultural education profession, the American Association for Agricultural Education (2001) created *National Standards for Teacher Education in Agriculture.* The standards were created for the purpose of teacher preparation program improvement and to assist in the consistent training of pre-service agriculture teachers. The standards addressed many areas, one of which was instruction. Included under the area of instruction was, "Agricultural education faculty instruction encourages the development of reflection, higher-order thinking, and professional disposition of teacher candidates" (Category II: Unit Capacity). This instruction would lead future teachers to assist their students in developing skills needed for a life of informed decisions. Many educational philosophers would argue that to make informed decisions a person must be able to synthesize information and evaluate options (Paul & Elder, 2004b; Lewis & Smith, 1993; Newman, 1990). According to Bloom (1956), Synthesis and Evaluation are the two highest levels of cognitive operations.

In 2000, *The National Strategic Plan and Action Agenda for Agricultural Education: Reinventing Agricultural Education for the Year 2020* (National Council for Agricultural Education, 2000) was published. The plan was developed to maintain and develop the place of agricultural education in the American school system. The plan included the mission for agricultural education, "Agricultural education prepares students for successful careers and a lifetime of informed choices in the global agriculture, food, fiber, and natural resources system" (p. 3). The inclusion of "informed choices" indicated the mission was grounded in developing higher-order thinking skills among agricultural education students.

A Taxonomy for Cognition

Bloom's Taxonomy has been used to organize teaching at various levels of thinking for almost fifty years and to distinguish between lower and higher order thinking skills. Three approaches for teaching higher-order thinking skills have been identified: Teach the content with higher-order thinking skills as a by-product, teach higher-order thinking skills with the content as the by-product, and teach higher-order thinking skills that can be transferred to other contents (Resnick, 1987). Questioning, writing, teaching the thinking process, and cooperative learning groups are techniques identified to assist in increasing higher-order thinking skills (Herrington & Oliver, 1999; Marzano, 1993; McGregor, 1994; Paul & Elder, 2004a).

Several methods and approaches for teaching (e.g., problem solving, cooperative learning, case study) include higher-order thinking skills as a goal (Arends, 1996; Johnson & Johnson, 1989). In combination with these methods and approaches, are teacher behaviors that promote the development of higher-order thinking skills. These specific teacher behaviors can be assigned to the levels of cognition and may be referred to as cognitive behaviors (Newmann, 1990). Cognitive behaviors are teacher actions that create opportunities for students to exercise cognitive operations. Newmann identified specific teacher behaviors that can be identified when studying teachers' cognitive behaviors. Those teacher behaviors included:

- Asking challenging questions and/or structured challenging tasks.
- Carefully considered explanations and reasons for conclusions.

- Pressing individual students to justify or to clarify their assertions in a Socratic manner.
- Encouraging students to generate original and unconventional ideas, explanations, or solutions to problems.
- Showing awareness that not all assertions emanating from authoritative sources are absolute or certain.
- Integrating students' personal experience (where relevant) into the lesson.
- Being a model of thoughtfulness.

(p. 51, 52)

Theoretical Framework

Similar to Newmann (1990), many researchers (Cruickshank, 1990; Dunkin & Biddle, 1974) have identified behaviors or questions for studying aspects of classroom teaching. Dunkin and Biddle identified a model for the study of classroom teaching that included four categories of variables. The four variable categories of the model were presage, context, process, and product. Presage variables were existing teacher characteristics which influenced their classroom behavior. Context variables were divided into two sub-categories: pupil, and school and community. The pupil category was existing student characteristics which influenced their behavior and learning. Characteristics from the community, school, and classroom that influenced student learning were also categorized under the context variables. The presage and context variables directly influenced the process variables. Process variables included the teacher and students' behavior and the interaction between the two. The final variables were the product variables. Pupil growth was categorized under the product variables. Dunkin and Biddle identified a linear relationship between the variables. Presage and context variables affected process variables, and the result of the process variables were product variables.

Cruickshank (1990) compiled a list of variables that could be categorized under each of the categories identified by Dunkin and Biddle (1974). Examples of presage variables included teacher age, sex, experience, education, and attitudes. School and class size, as well as composition (socioeconomic status) were included under the context variables. For process variables, Cruickshank included the teacher's use of structuring of comments, questioning techniques, and the level of difficulty of instruction. All three of the process variables included can be categorized as related to cognitive behavior. Additionally, Cruickshank included under the process variables the logical organization of content, "for example, by cognitive levels such as Bloom's Taxonomy of educational objectives" (p. 12).

Need for the Study

"Teaching should be offered 'in context,' that is, students should learn content while solving realistic problems. 'Learning in order to know' should not be separated from 'learning in order to do'" (U.S. Department of Labor, 1992, p. xvi). Collins, Brown, and Newman (1989) stated that most educational resources do not include efforts to develop higher-order thinking skills, nor do they include student activities that require metacognitive processes. Research (Underbakke, Borg, & Peterson, 1993) suggests that students' ability to think can be improved. "If teachers provided relevant experiences [to use higher-order thinking skills] in the classroom, students will learn to use these operations of thinking in the context of school subjects and perhaps more importantly, they will learn to monitor their own thinking" (Underbakke et al., p. 144). However, Lewis and Smith (1993) stated, "It is not safe and hence not desirable to assume that teachers know, or have been taught, how to teach higher-order thinking skills" (p. 136, 137).

Despite not knowing how to teach higher-order thinking skills, the instructor was found to be the most influential factor in creating opportunities for students to think at higher levels of cognition (Whittington, Stup, Bish, & Allen, 1997). Researchers (Cano & Newcomb, 1990) have concluded that teachers should assess the levels of cognition at which they are teaching and increase the levels of cognition as students increase in age and development. Unfortunately, when teachers' cognitive behaviors have been measured they have been predominantly at lower cognitive levels (Cano & Metzger, 1995). Whittington (1995) recommended the exploration of "barriers to teaching at higher cognitive levels" (p. 37). Also, instructors' cognitive behavior was not found to be associated with their attitude toward teaching at higher cognitive levels (Whittington, 1991). Lewis and Smith (1993) stated further research is needed on how higher-order thinking skills should be taught and how the skills should be incorporated into pre-service and in-service teacher programs. To study the skills that are needed for teachers, research must investigate the current status of the levels of teachers' cognitive behavior in the public school classroom. Research has not revealed how characteristics of teachers, schools, and/or classes affect teaching at higher levels of cognition or how related disciplines compare in teacher cognitive behaviors.

Problem Statement

The call for higher-order thinking skills in education has been initiated from federal mandates (*A Nation at Risk, Goals 2000,* U.S. Department of Labor, 1992), state legislation (MoSTEP, The Show-Me Standards), and educators (Dewey, 1933; Lewis & Smith, 1993; Paul & Elder 2004a; Resnick, 1987). Higher-order thinking is so important that the State of Missouri addresses the skills in both the student standards and the teacher certification standards. Students in Missouri's public schools must meet *The Show-Me Standards* (Missouri Department of Elementary and Secondary Education, 1996) to graduate. *The Show-Me Standards* include four broad goals, three of which include the skills to apply, analyze, solve problems, and/or make decisions. The standards for certification in Missouri (MoSTEP, 1999) include eleven performance standards one of which specifically includes instruction to encourage higher-order thinking.

Wenglinsky (2000) found strong support for the notion that conveying higher-order thinking skills leads to improved student performance. However, prior research (Ball & Garton, 2005; Cano, 1990; Cano & Metzger, 1995; Jimenez & Diaz, 1997; Whittington & Newcomb, 1993; Whittington et al., 1997) has indicated that teachers either do not know how to encourage higher-order thinking skills or simply do not choose to do so. Cano and Newcomb (1990) also concluded teachers "should assess the level of cognition of instruction being delivered to their students and if found to be unacceptable… corrective action should be taken" (p.51).

There is a lack of evidence of instruction of higher-order thinking skills and a widespread call for teaching these skills. In addition, very little evidence was present to indicate the factors influencing the cognitive behavior of teachers. The problem to be addressed with this study was: What factors influence the level of cognitive behavior among secondary teachers?

Purpose of the Study

The purpose of this study was to investigate the level of cognitive behavior exhibited by secondary agriculture teachers, how they compare to science teachers, and what characteristics are indicators of specific cognitive behaviors.

Research Objectives

For this study the following research objectives were used to address the problem and guide the study:

1. Describe the demographic characteristics (sex, age, years of teaching, highest degree, and certification area) of selected teachers.
2. Describe the characteristics of the schools (number of students, number of free and reduced lunch qualified students, and teacher to student ratio), and demographics of the classes (number of students, number of individualized instructional plans, sex, and classification).
3. Describe teachers' attitude toward teaching at higher levels of cognition.
    a. H_o: There is no difference in attitude toward teaching at higher levels of cognition between agriculture and science teachers (H_o: $\mu_{ag} = \mu_{sci}$).
4. Measure the level of cognitive behavior of teachers.
5. Describe how agriculture and science teachers compare by personal, school, and class characteristics.
6. Describe the difference in the level of cognitive behavior between agriculture and science teachers.

a. H_o: There is no difference in each of the six levels of cognitive behavior and lower and higher level behavior between agriculture teachers and science teachers ($H_{o\,(1-8)}$: $\mu_{ag} = \mu_{sci}$; 1= knowledge, 2 = comprehension, 3 = application, 4 = analysis, 5 = synthesis, 6 = evaluation, 7 = lower-order, 8 = higher-order).

b. H_o: There is no difference in mean cognitive behavior scores between agriculture teachers and science teachers (H_o: $\mu_{ag} = \mu_{sci}$).

7. Determine the predictability of the level of teachers' cognitive behavior on the basis of attribute characteristics.

   a. H_o: Teacher characteristics (sex, age, years of teaching, highest degree, content area, and attitude) will not predict teachers' level of cognitive behavior (H_o: $R^2 = 0$).

   b. H_o: School characteristics (number of students, percentage of free and reduced lunch qualified students, and teacher to student ratio) will not predict teachers' level of cognitive behavior (H_o: $R^2 = 0$).

   c. H_o: Class characteristics (number of individualized instructional plans, sex, and age) will not predict teachers' level of cognitive behavior (H_o: $R^2 = 0$).

Definitions

For the purposes of this study the following definitions were used:

Agriculture Teachers: Secondary teachers of agriculture, food, fiber and natural resources systems education (National Council for Agricultural Education, 2000).

Bloom's Taxonomy: A hierarchy of cognitive abilities, consisting of Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation (Bloom, 1956)

Cognitive Behavior: Personal conduct leading to conscious mental activity (such as thinking, remembering, learning, or using language) (Merriam-Webster Dictionary, 1997).

Critical Thinking: An attitude in which a person searches for ideas, manipulates previous knowledge and applies experiences (Von Oech, 1990)

Higher-Order Thinking: The upper four levels of Bloom's Taxonomy (Bloom, 1956) including Application, Analysis, Synthesis, and Evaluation. A cognitive process that occurs when a student "takes new information and information stored in memory and interrelates and/or rearranges and extends this information to achieve a purpose or find possible answers in perplexing situations" (Ball, 2002).

Levels of Cognition: The six levels (Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation) of Bloom's Taxonomy (Bloom, 1956) utilized to classify cognitive processes elicited by questioning strategies and/or verbal behavior (Ball, 2002).

Science Teachers: Secondary teachers of natural sciences (biology, chemistry, earth and space sciences, and physics) who know, understand, and teach the competencies of their discipline (National Science Teachers Association, 2003).

Assumptions

For the purposes of this study the following were assumed:

1. Bloom's Taxonomy is a valid framework for categorizing cognitive levels of instruction.

2. Teachers had all completed a teacher preparation program.

Limitations

1. The population of the study was limited to secondary (9-12) agriculture and science teachers. The courses observed were agricultural science II and biology (approximately sophomores).
2. Agricultural education and science programs where a student teacher was present were removed from the sample. Student teachers are generally placed with the best available teachers.
3. The findings of the study should not be generalized beyond similar populations.
4. Gall, Borg, and Gall (1996) indicate the presence of an observer can affect the typical classroom behavior of the subjects. The presence of an observer could alter the normal behavior of the subjects.
5. Analysis were limited by size of the sample.
6. Number of teachers observed was limited by the researcher time and resources.
7. Teacher selection was limited by willing teacher pairs and administrator.
8. Teachers' cognitive behavior was limited to measurement by the Florida Taxonomy of Cognitive Behaviors
9. Attitude toward teaching at higher levels of cognition was limited by the data collection instrument used in this study.

CHAPTER II

REVIEW OF LITERATURE

This chapter reviews related literature pertaining to the development of higher-order thinking skills. Areas to be examined include cognitive theory, value and importance of cognitive thinking, and factors influencing cognitive development.

Cognitive Theory

Almost fifty years ago, Bloom, along with several contributors, outlined six hierarchical levels of cognitive thought process (Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation) and associated behaviors. Together these levels are commonly referred to as Bloom's Taxonomy (Bloom, 1956). The taxonomy was developed for the categorization of education objectives.

Generally, Knowledge and Comprehension are considered lower-order thinking levels. Knowledge is defined as, "Behaviors and test situations which emphasize the remembering, either by recognition or recall, of ideas, materials, or phenomena" (Bloom, 1956, p. 62). Comprehension, "Includes those objectives, behaviors, or responses which represent an understanding of the literal message contained in communication" (p. 89).

Application, Analysis, Synthesis, and Evaluation are typically considered higher-order thinking. Application is defined as, "Given a problem new to the student, he will apply the appropriate abstraction without having to be prompted as to which abstraction is correct or without having to be shown how to use it in that situation" (Bloom, 1956, p. 120). Analysis is defined as, "The breakdown of the material into its constituent parts and detection of the relationships of the parts and of the way they are organized" (p. 144). Synthesis is defined as, "The putting together of elements and parts so as to form a whole" (p. 162). Evaluation, the final level, refers to "judgments about the value, for some purpose, of ideas, works, solutions, methods, material, etc." (p. 185).

Bloom (1956) stated that accomplishing higher-order thinking requires some analysis or understanding of the new situation. It requires background knowledge of methods that can be readily utilized. It also requires some facility in discerning the appropriate relations between previous experience and the new situation. The taxonomy was developed with the understanding that to accomplish a level of cognition, the previous levels must first be mastered. In addition, higher levels of cognition result in increased levels of retention. Solman and Rosen (1986) concluded that the Synthesis and Evaluation levels result in higher levels of retention than the lower four levels.

Criticisms of Bloom's Taxonomy

Furst (1981) identified criticisms of Bloom's Taxonomy. Bloom's Taxonomy (Bloom, 1956) was developed with R. W. Tyler's idea of educational objectives as changing behavior. The first criticism was the use of behavioral-specified goals that potentially confuse the objective with an indicator. This issue is a potential problem because learning may be covert or unobservable. Others have argued the taxonomy should have included a broad category of understanding as a goal of education (Hirst, 1974; Ormell, 1974).

When Bloom's Taxonomy is studied along side cognitive development, another criticism is identified. Solman and Rosen (1986) found that younger students had difficulty obtaining thought at the Synthesis and Evaluation levels. They concluded that complex operations should be used only with older students, possibly students of 15 or 16 years of age. Ormell (1974) pointed out that students can be assisted by teaching the taxonomy with content.

The taxonomy implies a boundary between the content and the process. Ormell (1974) stated, "This overlooks the fact that behaviors falling under the higher objects must, if they are to make sense, be based on true mappings (comprehension), true laws (application), true dissections (analysis), etc." (p.11). The processes that students are supposed to learn to use must be grounded in the content. Thus, the mastery of process is deeply associated with the mastery of content (Furst, 1981).

The linear design of the taxonomy has also been questioned. Hirst (1974) stated that knowledge is not usable without comprehension. Others have argued that evaluation is required in synthesis causing the Evaluation level to, at best, be equal with the Synthesis level (Kropp & Stoker, 1966; Madaus, Woods, & Nuttall, 1973; McGuire, 1963; Ormell, 1974; Wilson, 1971). Furst (1981) defended the taxonomy by stating:

> A handbook that has had over a million copies sold, been translated into several languages used worldwide, and cited thousands of times hardly needs extensive documentation on its usefulness… In general, the taxonomy has been used for developing comprehensive listings of objectives for particular subjects or entire curricula; describing courses, curricula, instructional materials, oral questioning in classrooms, and test materials with respect to objectives; planning courses and instruction; upgrading instruction; developing test materials and building test-item bans; and conduction research on the structure o learning outcomes (p. 448, 449).

Revised Cognitive Taxonomies

Newcomb and Trefz (1987), with consultation from David L. Krathwohl, one of the contributors of Bloom's Taxonomy (Bloom, 1956), condensed Bloom's Taxonomy from six levels into four levels. The four levels of Newcomb and Trefz are: Remembering, Processing, Creating, and Evaluating. Minimal explanation was given as to the rationale behind the change. Whittington (1995) inferred a further dichotomy of Newcomb and Trefz's model into lower-order thinking skills (remembering and processing) and higher-order thinking skills (creating and evaluating).

Most recently, Anderson and Krathwohl (2001) developed a revision of Bloom's Taxonomy. The authors made 12 changes to the cognitive dimension of the taxonomy. Four of the changes included renaming the Knowledge level to Remembering, renaming the Comprehension level to Understanding, and renaming the Synthesis level to Create. In addition, the order of the top two levels (Synthesis and Evaluation) was changed. Evaluate was changed to the fifth level and create became the highest level.

Research (Solman and Rosen, 1986) conducted on the original taxonomy indicated that the hierarchy was weak for the upper three categories. In response, Anderson and Krathwohl (2001) relaxed the assumption of cumulative nature of the hierarchy. The authors do however conclude that each level is more complex than those listed prior to it (Anderson & Krathwohl, 2001; Solman & Rosen, 1986). Two major changes in the taxonomy were changing of the cognitive dimension to verb components and relaxing the cumulative nature of the hierarchy. Anderson and Krathwohl changed the name of the six cognitive levels to verbs (Remember, Understand, Apply, Analyze, Evaluate, and Create) based upon the fact that the cognitive portion of objectives are usually verbs.

An additional dimension that was added to the taxonomy by Anderson and Krathwohl (2001) was Knowledge. There are four types of knowledge in the new taxonomy: Factual, Conceptual, Procedural, and Metacognitive. Anderson and Krathwohl stated,

> Factual Knowledge is knowledge of discrete, isolated content elements – 'bits of information'…. Conceptual Knowledge is knowledge of 'more complex, organized knowledge forms'…. Procedural Knowledge is 'knowledge of how to do something'…. Metacognitive Knowledge is 'knowledge about cognition in general as well as awareness of and knowledge about one's own knowledge' (p. 27).

Objectives can be placed within the taxonomy based on both (Process and Knowledge) dimensions (Anderson & Krathwohl, 2001). Each objective should have a cognitive process that aligns with one of the seven cognitive levels. In addition, objectives are written with some type of knowledge included. The knowledge portion of the objective is usually content specific. This content aligns with one of the four knowledge types.

It is widely recognized that there are levels of cognition. The model used or recognized varies based upon the background of the author. Figure 1 shows the comparison of Bloom's, Newcomb and Trefz's, and Anderson and Krathwohl's Taxonomies.

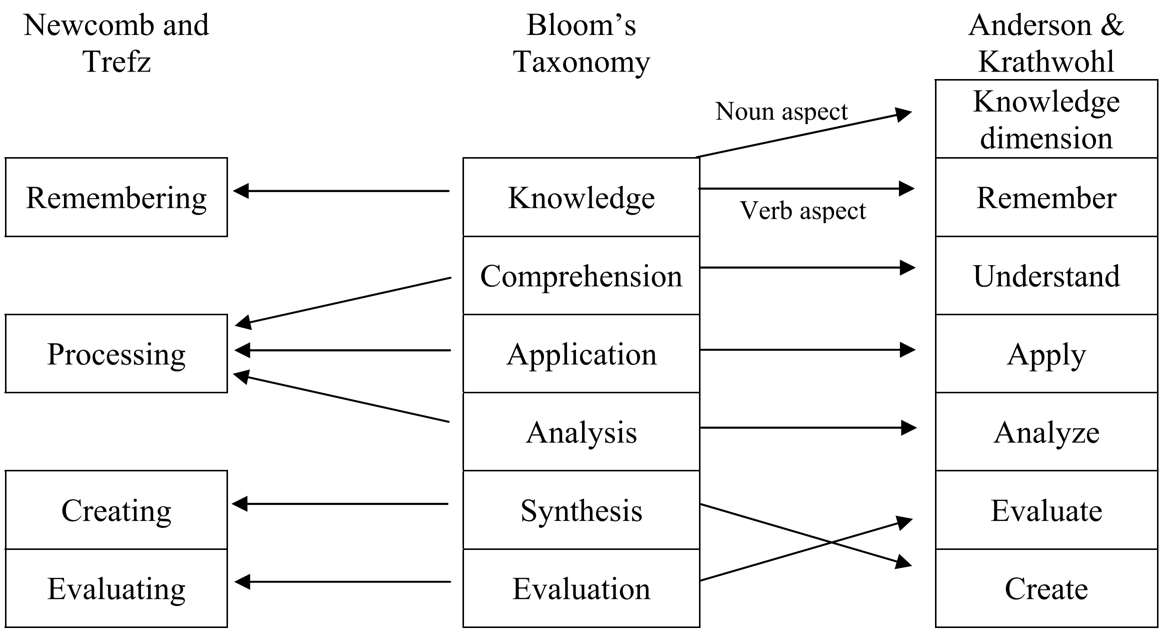

Figure 1. Summary of the structural relationship between Newcomb and Trefz, Bloom's, and Anderson and Krathwohl's taxonomies.

Although criticism of Bloom's Taxonomy have brought to light concerns about the taxonomy, Bloom's Taxonomy has remained widely accepted by educators. Revisions by Newcomb and Trefz created a condensed cognitive model, but was not supported by research. Anderson and Krathwohl developed a revised model which appears to have addressed many of the criticisms identified in Bloom's Taxonomy. Although Anderson and Krathwohl addressed the criticisms, the new taxonomy has not been subjected to research. The lack of empirical evidence for the two revised cognitive models, and the wide acceptance for the original taxonomy, guides this study to use Bloom's Taxonomy (Bloom, 1956) as a structure for classifying cognitive behavior.

Higher-Order Thinking

Newmann (1990) asked, "What is the difference between lower-order thinking and higher-order thinking?" In answering his own question, Newmann stated,

> Lower-order thinking demands only routine, mechanistic application of previously acquired knowledge; for example, repetitive exercises such as listing information previously memorized, inserting numbers into previously learned formula, or applying the rules for footnote format in a research paper. In contrast, higher-order thinking challenges the student to interpret, analyze, or manipulate information, because a question to be answered or a problem to be solved cannot be resolved through the routine application of previously learned knowledge (p. 44).

Educators agree that there is a difference between lower-order thinking and higher-order thinking (Lewis and Smith, 1993). However, the difference is influenced by prior knowledge held by the learner. What may require higher-order thinking by one learner may require lower-order thinking by another learner. Arguably, what may require higher-order thinking by a learner today may not require the same level of thinking tomorrow. That statement is to suggest that once something is learned and becomes memory, the cognitive process requires only lower-order thinking. Lewis and Smith stated that the varying levels of the learner requires teaching be interwoven at different levels of cognition. In addition, Maier (1933) stated that reasoning (higher-order thinking) can be attached to productive behavior. When material becomes learned behavior, it can be attached to reproductive thinking. This information implies that Bloom's Taxonomy may be cyclical (Figure 2). When a person completes his/her productive thinking and becomes learned behavior, the reproductive thinking becomes a process at the lower levels of cognitive thought. The process of productive thinking (higher-order thinking) is commonly referred to by many names.

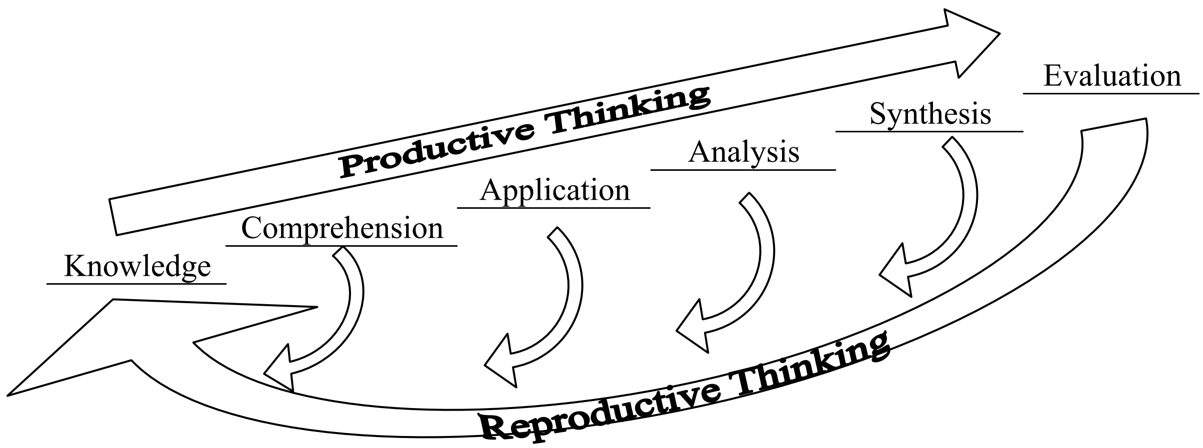

Figure 2. The cyclic nature of Bloom's Taxonomy.

The term, "critical thinking" has been inconsistently used, adding to the confusion in defining higher-order thinking (Lewis & Smith, 1993). "Critical thinking has been assigned at least three distinct meanings: a) critical thinking as problem solving, b) critical thinking as evaluation or judgment, and c) critical thinking as a combination of evaluation or problem solving" (Lewis & Smith, p. 134). Beyer (1985) concluded that critical thinking was not an overarching term for thinking skills. Critical thinking is "the assessing of the authenticity, accuracy, and/or worth of knowledge claims and arguments" (p. 271). Lewis and Smith argued that critical thinking is not the same as problem solving. The authors stated that physicians who have been trained in problem solving for identifying a medical problem are many times confronted with ethical problems that require critical thinking for a solution.

Lewis and Smith (1993) concluded a term broader than critical thinking is needed to include problem solving, creative thinking, decision making, reasoning, and critical thinking. Higher-order thinking was the term that they suggested. The authors also formulated a definition: "Higher-order thinking occurs when a person takes new information and information stored in memory and interrelates and/or rearranges and extends this information to achieve a purpose or find possible answers in perplexing situations" (p. 136). With Maier's (1933) statement of the material changing from productive behavior to reproductive thought, arguably this definition should also include higher-order thinking as a process.

Value and Importance of Cognitive Thinking

Beyer (1987, p. 2) asked, "Why is the teaching of thinking so important?" Several decades earlier, Dewey (1933) stated, "If thought is a distinct piece of mental machinery, separate from observation, memory, imagination, and common-sense judgments of persons, and things, then thought should be trained by special exercises designed for the purpose" (p. 55). Beyer identified three reasons for schools and teachers to be concerned about teaching thinking. First, many believe higher-order thinking is a skill that develops on its own. This assertion is not completely true. Most people, especially inexperienced thinkers, are not as able to develop thinking skills if left to their own. Left to themselves people will most likely fail to develop their thinking skills to their fullest potential. People need assistance to develop effective thinking skills. Beyer further stated,

> Teachers daily create situations by asking questions, assigning writing tasks, giving test, in which students must think and then be passed or failed on the products of their thinking. Outside the school, students repeatedly encounter situations, in purchasing goods, relating to others, completing chores at home, and, someday, joining various social and political organizations and voting, where skillful thinking [higher-order thinking] is critical to their success (p. 2-3).

Beyer's (1987) assertion led to a second reason for teaching the skills of thinking. If teachers do not "deliberately and explicitly teach how to execute the various thinking tasks required for academic as well as common out-of-school task, students' chances of success at these tasks are greatly limited" (p. 3).

A third reason for teaching thinking skills is to assist teachers and schools. Many states are mandating standards for student achievement, requiring the teaching of thinking skills. Although most state standards are not written specifically in the form of developing thinking skills, many are written in a form where students are expected to master more than just knowledge of content (Beyer, 1987).

Student achievement is not only a state concern. On August 26, 1981, The National Commission on Excellence in Education was created by then Secretary of Education, T. H. Bell. The commission was charged with the task of examining the quality of education in the United States. The commission spent 18 months collecting information and completed their task with the release of *A Nation at Risk: An Open Letter to the American People* (National Commission of Excellence in Education, 1983). The commission stated, "knowledge, learning, information, and skilled intelligence are the new raw materials of the international commerce" (p. 7). In the information age, learning is required for success. Common understanding about complex issues is required for our country to function. At the time of *A Nation at Risk,* nearly 40% of 17-year-olds did not possess higher-order skills and could not draw inferences or conclusions from written material. During the legislative hearings conducted by the commission, testimony was heard by those who worried "schools may emphasize such rudiments as reading and computation at the expense of other essential skills such as comprehension, analysis, solving problems, and drawing conclusions" (p. 10).

The National Commission of Excellence in Education (1983) pointed out that within the constitution of the United States, citizens are promised the tools and a fair chance for success. Based on this statement, the Commission stated:

> This promise means that all children by virtue of their own efforts, competently guided, can hope to attain mature and informed *judgment* needed to secure gainful employment, and to manage their own lives, thereby serving not only their own interest but also the progress of society itself (emphasis added) (p. 8).

A Nation at Risk included recommendations for implementation. Of the five major content areas discussed, English, mathematics, science, social studies, and computer science, all specifically mention higher-order thinking skills. For example, the report stated that within the science recommendations, graduates should be introduced to “the application of scientific knowledge to everyday life” (p. 25).

Continuing the task of improving education, a federal act, *Goals 2000: A World-Class Education for Every Child*, was passed on March 31, 1993 (Department of Education, 1993). *Goals 2000* served as an outline for improving schools. The plan included suggestions for states, communities, schools, and individuals to assist in the improving of the local educational system. *Goals 2000* suggested questions to ask of the school system to assist in finding areas to improve. Included were questions that related to higher-order thinking. For example (Department of Education):

- Are all students reading, discussing, and debating important ideas found in history and literature?
- Are they using math and scientific knowledge to solve complex experiments?
- Are they using geographic knowledge and the arts to ask good questions and to see connections?
- Are they communicating and thinking clearly?
- Are students becoming more responsible for their own learning?
- Do teachers assign homework that challenges students to apply what they’re learning?

- Do all children aim for higher levels of learning?
- Do assessments look at how well students use what they're learning to do the basics, to solve problems, and to communicate in core subjects?

(p. 17-19)

While federal documents offered guidelines for improving the quality of education, state efforts were also present. The Missouri Department of Elementary and Secondary Education (MoDESE) (1996) raised the question, "What do high school graduates in Missouri need to know and be able to do" (Note to Readers section)? Those who were brought together to answer the question agreed that knowing and doing are not the same, but are closely related. MoDESE identified six content areas with 40 knowledge standards and four performance goals with 33 performance standards. The efforts resulted in the creation of *The Show-Me Standards* (MoDESE). Within *The Show-Me Standards* document, multiple standards related to higher-order thinking. For example, "Students in Missouri public schools will acquire the knowledge and skills to gather, analyze and apply information and ideas" (Performance section).

Paul and Elder (2004b) state that the quality of life depends on a person's higher-order thinking abilities. They added that it is natural for people to think, but also naturally occurring are biases, distorted thinking, partial and uniformed thinking, and prejudice. Poor thinking is costly in both money and quality of life. But, excellence in thinking must be deliberately shaped. Higher-order thinking is directed, disciplined, self-monitored, and corrective thinking.

Elder (2004) concluded that our educational system should be guided by robust higher-order thinking opportunities. Haynes and Schroeder (1989) stated that for students to succeed after school, education must give them the skills to be workers and citizens.

Factors Influencing Cognitive Development

Agricultural educators have traditionally promoted the benefits of hands-on activities (Newcomb, McCracken, Warmbroad, & Whittington, 2004). Johnson, Wardlow, and Franklin (1997) assessed the effects on student cognitive achievement and attitude from hands-on activities when compared with a worksheet activity. Johnson et al. did not find a relationship between hands-on activities and cognitive achievement. However, they concluded that students' attitudes toward learning were significantly increased. This finding was deemed an important discovery. However, Wenglinsky (2000) reported a positive relationship between hands-on learning and higher-order thinking skills development.

Other research discoveries included two broad categories for teaching higher-order thinking: higher-order thinking in the disciplines and general higher-order thinking skills (Resnick, 1987). General higher-order thinking skills are specific classes that teach the skills that can be transferred among disciplines. Higher-order thinking skills in the discipline encompass the integration of higher-order thinking techniques and skills into a given discipline. Marzano (1993) listed three accepted techniques used to enhance student thinking: questioning, writing, and teaching of process strategies. Marzano also identified two types of questions: recitation and construction. Recitation questions are answered with the recalling of information. Construction questions require students to recall previous knowledge and construct new knowledge.

Questioning can be presented in other forms, such as research papers. "Although assigning research papers has long been a standard way of assessing knowledge, many library media specialist believe that learning an effective process is as important as producing a final product" (McGregor, 1994, p. 125). McGregor sought to answer "What is the nature of higher-order thinking skills employed by high school students as they used information for writing a research paper" (p. 125)? The author interviewed and observed the participants and concluded: (a) Cognitive operations were conducted without awareness of the process. Students were not aware of the thinking they were conducting. (b) Thinking occurred both about the information and about the source. Thinking about both was deemed partially higher-order. (c) Thinking progresses naturally through the levels of thinking from lower-order to higher-order. Students had to first gain knowledge about the information before they could work their way up to evaluating. This illustrates completing the levels of higher-order thinking. (d) The level of thinking was affected by the questions being asked. If the assignment was only factual, thinking did not reach higher cognitive levels. (e) Students' ultimate goal was the product not the process. Students did not think about their thinking processes, they just thought about the product they were working toward.

McGregor (1994) concluded "students do not instinctively operate in a metacognitive manner. A metacognitive environment in which thinking strategies are discussed, modeled, monitored, and evaluated in a supportive atmosphere could help students as they learn to think about using information more effectively" (p. 131). She also concluded research papers provide opportunities to practice higher-order thinking. "If higher-order thinking is a goal, information questions should be phrased to require those levels of thinking" (McGregor, p. 132).

Herrington and Oliver (1999) placed students in cooperative learning groups to observe their problem solving techniques. Students were given two problems and multiple resources to use when considering a solution. The researchers transcribed all discussion for analysis. The analysis showed higher-order thinking made up 70% of the "total talk" being conducted. The authors concluded that situated learning provided a learning environment capable of supporting and maintaining substantial levels of higher-order thinking. They also discovered groups that had not previously worked together appeared to use different types and proportions of thinking. It was concluded that social ease and experience at collaboration assists in higher-order thinking.

"If we are to better understand how to promote thinking in the classroom, we need to learn more about the work of practitioners" (Onosko, 1989, p. 175). Onosko compared the thought of teachers who promoted student thinking on a consistent basis and those teachers who promoted student thinking less consistently. With the comparison, Onosko found that teachers who promoted student thinking viewed student thinking as the goal, with the content as the vehicle. Teachers who promoted student thinking less viewed the content as the primary goal with thinking as a byproduct. In another study, Onosko (1990) compared the instruction delivered to two groups. He found that those who promoted student thinking "almost always included teacher-centered whole-group discussion and student note taking. Their lessons were also more likely to include primary source and teacher-generated reading materials than textbook readings" (p. 458). Teachers who promoted student thinking less were more likely to teach using lecture or recitation and use the textbook more frequently.

Cognitive Instruction in Post-Secondary Education

Whittington and Newcomb (1993) studied the aspired cognitive level of instruction, assessed cognitive level of instruction, and attitude toward teaching at higher cognitive levels held by college instructors. The authors compared the aspired cognitive level and the actual cognitive level of instruction of the participants. Participants were also interviewed to assess their attitude toward teaching at higher levels of cognition. Participants aspired to teach at high levels of cognition, but primarily taught at the lowest level. Participants also aspired to test at higher levels, but actually tested over the lowest few levels of thinking. Participants did however have favorable attitudes toward teaching at higher cognitive levels. Those who had more favorable attitudes toward teaching at higher levels of cognition tested more at the middle levels, but still not at the highest.

Ball and Garton (2005) conducted a study to compare course objectives, classroom behavior, and assessments of teacher preparation courses. They found the majority of the observed instructors were writing course objectives and assessments at higher levels of instruction than they were teaching. The majority of the instructors wrote course objectives and assessment at the same level. However, the delivery of the material did not measure as high. It was concluded that teacher educators were "teaching their students to conduct classroom discourse at lower levels of cognition" (p. 66). Ball and Garton recommended similar research to explore objectives, classroom discourse, and assessments of beginning teachers.

Whittington, Stup, Bish, and Allen (1997) studied the opportunities for student thinking provided by college professors. The researchers started the project with the assumption that opportunities would change based on course level, class size, and time across the semester. It was rationalized that students would be more capable of higher-order thinking as the semester progressed and their course work increased. Also, smaller class sizes were thought to have more opportunities for behavior leading to opportunities for thinking. None of the variables were found to have a relationship with the professors' assessed cognitive behavior. Whittington, et al. stated, "In each case, it appeared that the factor most affecting the frequency of opportunities given to students to think at higher cognitive levels was the professor" (p. 51). Whittington, et al. also concluded that college students should think at high levels of cognitive to learn new information and be challenged. Arguably, both of the previous statements could be applied to all levels of education.

To further study the topic of cognitive instruction, Whittington (1998) implemented three levels of intervention to study the effects on the level of cognitive discourse (verbal instruction) among college professors. Professors were divided into three groups. All groups were introduced to their level of cognitive discourse and given suggested techniques for improving. For group one, this was their only intervention. Group two was sent monthly readings on improving cognitive instruction and were asked to write a description of how they planned to apply the information. The third group was involved in eight workshops on improving their cognitive level of instruction. The workshops were one hour long and occurred once a month. Whittington found that while all three interventions improved the cognitive level of instruction, more intervention resulted in more higher-level cognitive discourse.

Higher-Order Thinking in Secondary Science Education

Science laboratory activities were studied for their ability to develop students' knowledge (Jimenez & Diaz, 1997). Teachers' discourse was one aspect of the study. The authors concluded that there is a gap between the opportunities that lab work should provide for developing knowledge, and the activities actually performed. The classroom discourse between the teachers and students was found to be mainly technical in nature. The oral questions presented by the teachers related to lower levels of cognition.

"Science students whose teachers have received professional development in higher-order thinking skills outperformed their peers by 40% of a grade level" (Wenglinsky, 2000, p. 8). A similar finding occurred with math teachers who emphasized higher-order thinking. Wenglinsky linked classroom teaching practices to student academic performance. Additionally, Wenglinsky found that the teaching of higher-order thinking skills leads to improved student performance.

Higher-Order Thinking in Secondary Agricultural Education

A comparison of students' cognitive level of performance and their critical thinking ability was conducted by Cano and Martinez (1991). The Developing Cognitive Abilities Test showed that secondary horticulture students' level of cognitive performance increased as their grade level increased with one exception, eleventh grade students scored slightly lower than tenth graders. When assessing critical thinking ability with the Watson-Glaser Critical Thinking Appraisal the same trend was found except eleventh graders scored lowest. A positive relationship between the two assessments was found. Cano and Martinez concluded, "As scores on one test increased, a corresponding increase was found on the other test" (p. 28). Additionally Cano and Martinez stated, "These findings suggest the importance for agricultural educators to challenge students to develop cognitive abilities and critical thinking abilities at higher levels via the instruction they provide" (p. 28).

Cano and Newcomb (1990) studied the planned instruction of high school agriculture teachers, based upon written objectives. The authors also measured the level of cognitive achievement of the students. Agriculture teachers were writing more instructional objectives at higher cognitive levels than suggested by previous literature (Gall, 1970; Kirts & Stewart, 1983). Students in the study were also performing at higher levels of cognition than previous studies (Gall, 1970; Ryan, 1973) had suggested. Cano and Newcomb (1990) concluded that teachers should determine if their level of cognitive instruction is acceptable to challenge the students at all levels of cognition. Also, the cognitive level of instruction should increase with the grade level of the students. (Cano & Newcomb).

Throughout the 1987-1988 academic year, Cano (1990) assessed planned classroom instruction by evaluating objectives within a course of study. He also evaluated students' levels of cognitive performance using a purposely designed test. On the Newcomb-Trefz higher-order thinking model, Cano found that 69% of the course objectives were above the "remembering" level. The level of cognitive thinking performance for students decreased as questions moved toward the evaluating level. "The students answered approximately 64% of remembering-level questions, 55% of the processing-level questions, 40% of the creating-level questions, and 28% of the evaluating questions" (p. 76). Cano concluded that a relationship at significant levels was present between the level of instruction and the level of student cognitive performance. He concluded, “Higher values of teacher remembering, processing, creating, and evaluating were associated with higher values on student performance” (p. 79).

Cognitive level of instruction is another area that can impact student performance. Cano and Metzger (1995) measured the cognitive level of instruction for high school horticulture teachers. The Florida Taxonomy of Cognitive Behavior (Brown, Ober, Soar, & Webb, 1968) was used to assess the cognitive level of instruction. Teaching occurred at lower levels of cognition 84% of the time and at Synthesis and Evaluation levels a combined percentage of 3.7% of the time. Teachers were also found to have a mean weighted cognitive score of 23.03. It was “recommended that continual education on enhancing teaching at higher levels of cognition be a priority of in-service seminars so that the teachers… can increase the level of cognition at which they teach” (p. 40).

A Framework for Studying Classroom Teaching

Newmann (1990) identified general teacher behaviors that could be addressed for studying cognitive behavior. However, Dunkin and Biddle (1974) identified factors beyond the teacher. Dunkin and Biddle identified four categories of factors for studying classroom teaching. The categories included: teacher, school and students, classroom behavior, and outcomes. Cruickshank (1990) built further upon the Dunkin and Biddle model to identify additional possible variables. Newmann’s identified behaviors included:

- The teacher asked challenging questions and/or structured challenging tasks.

- The teacher carefully considered explanations and reasons for conclusions.
- The teacher pressed individual students to justify or to clarify their assertions in a Socratic manner.
- The teacher encouraged students to generate original and unconventional ideas, explanations, or solutions to problems.
- The teacher showed an awareness that not all assertions emanating from authoritative sources are absolute or certain.
- Students' personal experience (where relevant) was integrated into the lesson.
- The teacher was a model of thoughtfulness.

(p. 51, 52)

Dunkin and Biddle (1974) identified a model for studying classroom teaching (Figure 3). The model has four major variable types: presage, context, process, and product. Presage variables are existing characteristics that influence the teacher and their behavior. Context variables are divided into two sub-categories: "pupil" and "school and community". The pupil category is existing characteristics of the students that influence their behavior and learning. Characteristics from the community, school, and classroom that influence student learning are also categorized under the context variables. Presage and context variables directly influence process variables. Process variables include the teacher and students' behavior and the interaction between the two. The final variables are the product variables. Pupil growth is categorized under the product variables. Dunkin and Biddle identified a linear relationship between the variables. Presage and context variables affect process variables and the result of the process variables are the product variables.

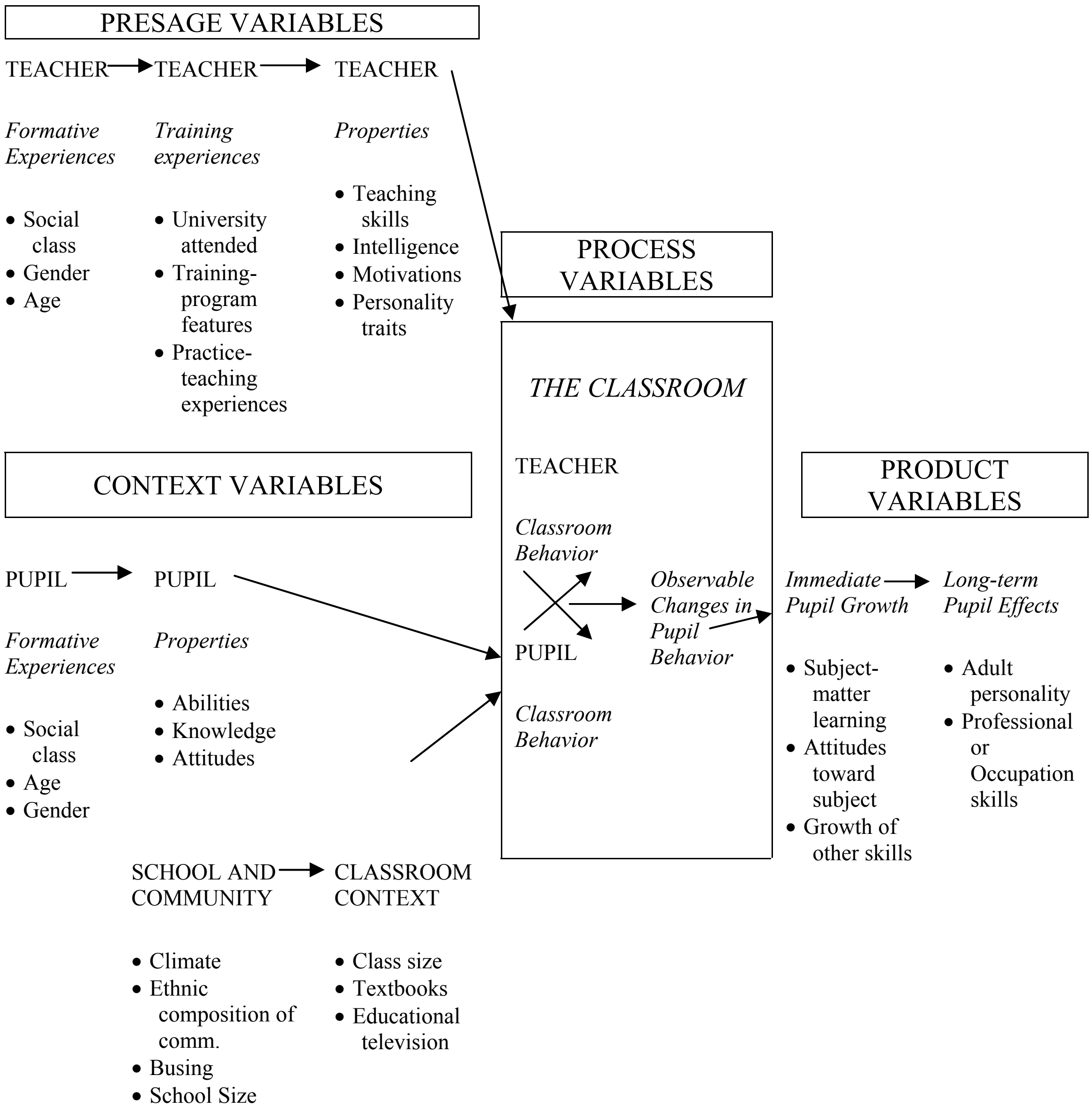

Figure 3. A model for the study of classroom teaching (Dunkin & Biddle, 1974).

Similar to Newmann (1990), Cruickshank (1990) compiled a list of variables that could be used to study classroom teaching. Cruickshank extended the variables from Dunkin and Biddle's (1974) model. For process variables, Cruickshank included the teacher's structuring of comments, questioning techniques and the level of difficulty of instruction. All three of the process variables were categorized as related to cognitive behavior. Cruickshank included with process variables the logical organization of content, “for example, by cognitive levels such as Bloom’s Taxonomy of educational objectives” (p. 12). Variables of interest for this study were categorized under the presage, context, and process variables (Dunkin & Biddle). Presage variables included, teacher age, sex, experience, education, and attitudes. School and class size, and composition (socioeconomic status) were included under the context variables.

Summary

The Constitution of the United States promises all citizens the tools for success. This promise is built on the foundation of education (National Commission of Excellence in Education, 1983). Beyer identified three reasons for teaching thinking skills: thinking does not develop on its own, to increase students’ chances for success, and to assist the teachers and the school system. The call for higher-order thinking in education has become louder over the past twenty-five years (Department of Education*,* 1993; MoDESE, 1996; National Commission of Excellence in Education).

Continued debate has occurred on definitions relating to the higher-order thinking. Bloom (1956) identified a taxonomy for classifying cognitive behaviors. The taxonomy included six levels of cognition: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. The first two levels are commonly referred to as lower-order thinking (Bloom). The other four levels are commonly referred to as higher-order thinking (Bloom).

Bloom’s Taxonomy was criticized by several educational scholars (Furst, 1981; Hirst, 1974; Kropp & Stoker, 1966; Madaus et al., 1973; McGuire, 1963; Ormell, 1974;

Solman & Rosen, 1986; Wilson, 1971). As a result, modifications were made to Bloom's Taxonomy, including condensing Bloom's Taxonomy into four levels rather than six. Those levels were: Remembering, Processing, Creating, and Evaluating (Newcomb & Trefz, 1987). Anderson and Krathwohl (2001) presented the "Revised Bloom's Taxonomy." Where the original Bloom's Taxonomy was divided into two dimensions: Cognitive and Knowledge. The Cognitive dimension pertains to the thought processes in learning and the Knowledge dimension relates to the content taught. In addition, Anderson and Krathwohl changed the names of the Knowledge, Comprehension, and Synthesis levels to Remember, Understand, and Create, respectively.

Beyer (1985) concluded critical thinking was not an overarching term for thinking skills. Lewis and Smith (1993) suggested that higher-order thinking be used as the overarching term. "Higher-order thinking occurs when a person takes new information and information stored in memory and interrelates and/or rearranges and extends this information to achieve a purpose of find possible answers to perplexing situations" (Lewis & Smith, p. 136). Newmann, stated, "Lower-order thinking demands only routine, mechanistic application of previously acquired knowledge…. In contrast, higher-order thinking challenges the student to interpret, analyze, or manipulate information" (p. 44).

Educators consider three ways of teaching higher-order thinking: teach the content with higher-order thinking as a by-product, teach higher-order thinking with the content as the by-product, and teach higher-order thinking that can be transferred to other contents (Resnick, 1987). Questioning, writing, teaching the thinking process and cooperative learning groups, are ways identified to increase higher-order thinking (Herrington & Oliver, 1999; Marzano, 1993; McGregor, 1994).

Research has been conducted on the cognitive level of instruction in post-secondary instruction. Teachers with favorable attitudes toward teaching at higher levels did not teach at higher levels of cognition (Whittington & Newcomb, 1993). Teacher educators were found to not model higher levels of cognition in their classrooms (Ball & Garton, 2005). The greatest factor toward students' opportunities to think at higher levels of cognition was the instructor (Whittington et al., 1997).

The cognitive behavior of secondary agriculture teachers has been assessed (Cano, 1988; Cano & Metzger, 1995). These studies found that agriculture teachers planned for higher-order thinking and they belied that the instruction is important. Additionally, secondary science teachers and the opportunities in their classes have been assessed for the teaching of higher-order thinking (Jimenez & Diaz, 1997; Wenglinsky, 2000). The studies of the science classrooms showed room for improvement. No studies were found in the review of literature that conducted a comparison of teachers from different disciplines. In addition no research investigating relationships to teacher, school, and/or class characteristics were found.

Variables for studying classroom teaching have been developed (Cruickshank, 1990; Dunkin & Biddle, 1974; Newmann, 1990). Variables included in this study related to the teacher, the school and the students. All three of these areas can affect teacher and student behavior, and cognitive development (Cruickshank; Dunkin & Biddle; Newmann). The evaluation of these variables can help researchers understand the cognitive behavior of secondary teachers. Also, information about these variables can lead to insight into the factors related to cognitive behavior.

CHAPTER III

METHODOLOGY

Purpose of the Study

The purpose of this study was to investigate the level of cognitive behavior exhibited by secondary agriculture teachers, how they compare to science teachers, and what characteristics are indicators of specific cognitive behaviors.

Research Objectives

For this study the following research objectives were used to address the problem and guide the study:

1. Describe the demographic characteristics (sex, age, years of teaching, highest degree, and certification area) of selected teachers.
2. Describe the characteristics of the schools (number of students, number of free and reduced lunch qualified students, and teacher to student ratio), and demographics of the classes (number of students, number of individualized instructional plans, sex, and classification).
3. Describe teachers' attitude toward teaching at higher levels of cognition.
    a. H_o: There is no difference in attitude toward teaching at higher levels of cognition between agriculture and science teachers (H_o: $\mu_{ag} = \mu_{sci}$).
4. Measure the level of cognitive behavior of teachers.

5. Describe how agriculture and science teachers compare by personal, school, and class characteristics.
6. Describe the difference in the level of cognitive behavior between agriculture and science teachers.
    a. H_o: There is no difference in each of the six levels of cognitive behavior and lower and higher level behavior between agriculture teachers and science teachers ($H_{o\,(1-8)}$: $\mu_{ag} = \mu_{sci}$; 1= knowledge, 2 = comprehension, 3 = application, 4 = analysis, 5 = synthesis, 6 = evaluation, 7 = lower-order, 8 = higher-order).
    b. H_o: There is no difference in mean cognitive behavior scores between agriculture teachers and science teachers (H_o: $\mu_{ag} = \mu_{sci}$).
7. Determine the predictability of the level of teachers' cognitive behavior on the basis of attribute characteristics.
    a. H_o: Teacher characteristics (sex, age, years of teaching, highest degree, content area, and attitude) will not predict teachers' level of cognitive behavior (H_o: $R^2 = 0$).
    b. H_o: School characteristics (number of students, percentage of free and reduced lunch qualified students, and teacher to student ratio) will not predict teachers' level of cognitive behavior (H_o: $R^2 = 0$).
    c. H_o: Class characteristics (number of individualized instructional plans, sex, and age) will not predict teachers' level of cognitive behavior (H_o: $R^2 = 0$).

Research Design

The design of this study was descriptive-correlational. Gall, Borg, and Gall (1996) define descriptive research as, “A type of investigation that measures the characteristics of a sample or population on pre-specified variables” (p. 757). In this study, the predictability of teachers’ cognitive behavior on the basis of their characteristics was examined. Correlational, or predictive, research is used to predict a phenomenon from existing information (Gall, et al). Although often used in social science research, correlational research is only as good as the existing information. Gall, et al. indicated that relationships can be due to none measured variables such as underlying variables or biased raters. To fully explain correlations, experimental research must be conducted.

Variables of Interest

Cognitive behavior is the teacher’s personal conduct leading to conscious mental activity (Merriam-Webster Dictionary, 1997) and was measured using the Florida Taxonomy of Cognitive Behavior (Brown, Ober, Soar, & Webb, 1968). Attitude toward teaching at higher-levels of cognition was measured using a 50 question, summated rating scale questionnaire. Attitude was determined based on the teachers’ level of agreement to the 50 questions. Teachers’ personal and professional characteristics (age, sex, years of teaching, highest degree, and certification areas) were self-reported on the questionnaire. Also collected on the questionnaire were selected classroom characteristics (number of female student, number of male students, number of students with Individualized Educational Plans (IEPs) and the students’ classification). The school characteristics (total number of students, percentage of free and reduced lunch qualified students and student to teacher ratio) were collected on the website of Missouri Department of Elementary and Secondary Education (2005b). School data were for the 2003-2004 school year, and were compiled from schools' annual reports.

Population

The target population for this study was secondary agriculture teachers in Missouri ($N = 454$). The accessible population was secondary agriculture teachers within a 50 mile radius of Columbia, Missouri who taught in a school with seven-period days. Additionally, teachers who were serving as a supervisor of a student teacher were removed from the population. In total, 53 ($N = 53$) teachers were found in schools that met the requirements. Names were drawn from the 2004-2005 teacher in-service list.

To reduce bias in the selection process, all teachers within schools meeting the requirements were placed in a database and ten ($n = 10$) schools were randomly selected to participate in the study. Agriculture teachers within each selected school who taught agricultural science II were contacted by the researcher. Teachers were contacted by phone to inquire about their interest in participating in the study. To assure each teacher received the same information, a written script (see Appendix A) was used. If the agriculture teachers agreed to participate, he/she was asked to identify a biology teacher within their school system to be included in the study. For comparison purposes, the identified biology teacher at each school was contacted to determine their willingness to participate. A written script (see Appendix B) was also used with the science teachers when they were contacted by phone. Agriculture teachers were not used without a cooperating science teacher. Following positive interest from both the agriculture and science teachers, the school's administrator was called to seek permission. A written script (see Appendix C) was also used with the administrator to insure consistent communication of information. After verbal permission was granted, the administrator was sent an official letter of participation (see Appendix D). Schools where either teacher (agriculture or science) or the administrator declined to participate were removed from further consideration. Replacement subjects were randomly selected from the remainder of the assessable population.

Instrumentation

For the purposes of this study two data collection instruments were used: the Florida Taxonomy of Cognitive Behaviors and an attitudinal questionnaire.

Cognitive Behavior

Collection of the level of the teacher's classroom cognitive behavior was obtained using the Florida Taxonomy of Cognitive Behaviors (FTCB) (Brown, et al., 1968).

> The FTCB provides a framework for observing and recording the cognitive behaviors of teachers and [/or] students in the classroom. The system can be used directly by an observer in the classroom to assess the cognitive level of functioning of teachers and [/or] students (Simon & Boyer, 1970, p. 42).

The FTCB (See Appendix E) was developed based on Bloom's Taxonomy, but the two are not identical (Miller, 1989). While Bloom (1956) identify six major levels of cognition, the FTCB recognizes seven levels (Miller, 1989). The FTCB measures Knowledge, Translation, Interpretation, Application, Analysis, Synthesis, and Evaluation. Within the FTCB, the levels of Translation and Interpretation are aligned with Bloom's Comprehension level. The four higher levels of both taxonomies are similar: Application, Analysis, Synthesis, and Evaluation. Figure 2 presents the alignment of the FTCB and Bloom's Taxonomy.

Table 1

Comparison of Bloom's Taxonomy and the Florida Taxonomy of Cognitive Behaviors

Bloom's Taxonomy	Florida Taxonomy of Cognitive Behaviors
Knowledge	Knowledge
Comprehension	Translation
	Interpretation
Application	Application
Analysis	Analysis
Synthesis	Synthesis
Evaluation	Evaluation

Note. Adapted from Miller, 1989.

Bloom (1956) identified categories of behavior under each of the six levels of cognition (Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation) that are indicative of behavior at that level. Miller (1989) stated,

> The FTCB includes 55 such [behavior] categories. Approximately one-third of these 55 categories are indicators of the Knowledge level of cognition and are classed under the areas of knowledge of specifics, knowledge of ways and means of dealing with specifics, and knowledge of universals and abstracts. The Translation level includes six [behavior] categories of behavior that indicate the use of knowledge by restating facts in a different form or by giving examples. The Interpretation level also includes six [behavior] categories. This level focuses upon thought which is indicative of an understanding of relationships (i.e. giving reasons) (p. 42).

The remaining four cognitive levels of the FTCB (Application, Analysis, Synthesis, and Evaluation) have four, eleven, nine, and two behavior categories as indicators, respectively.

The FTCB is used to categorize teachers' cognitive behaviors observed in six-minute intervals of a teaching session. As teacher behaviors were observed, corresponding box(s) were marked within the cognitive category. Behaviors were recorded only once per six-minute interval, regardless of the number of times it occurred. For example, if a teacher gives a fact three times in a six-minute interval, the corresponding box is only marked once, indicating the behavior had occurred. In addition to verbal communication, directed activities and written instructions such as visuals or handouts were also categorized into cognitive categories.

Attitude and Demographics

To collect demographic data and attitude toward teaching at higher levels of cognition, a questionnaire developed by Whittington (1991) (see Appendix F) was adapted. Changes and additions to the questionnaire design were made based on Dillman's (2000) *Tailored Design Method.* The instrument was formatted into a questionnaire booklet to increase readability. The front of the booklet was printed on colored paper and included the title, a graphic representation of a teacher, and information pertaining to the sponsoring institution. The inside cover of the questionnaire included a reminder of Bloom's Taxonomy. The inside pages of the booklet were printed on white paper with 12-point black font for ease in reading. Questions were grouped together by topic. The first section of questions related to the teacher's attitude. Teacher demographic information was collected in the second section, followed by class demographics. Attitude toward teaching at higher levels of cognition was assessed using 50 summated rating scale questions. Questions were aligned in one column per page to avoid questions being overlooked. Additionally, even number questions were formatted with a light shaded background to create separation.

Each of the 50 questions consisted of a statement and a six-point scale of agreement. Seventeen questions were written with negative phrasing in an attempt to avoid response set. Response set is the tendency to answer questions without reading with the assumption that all questions are positively phrased. Directions were placed at the beginning of each section. Participants were asked to read each statement and indicate their level of agreement to each. The scaled response choices were: 1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = slightly agree, 5 = moderately agree, 6 = strongly agree. At the top of each page that included attitude questions, a reminder of the scale of agreement was included.

The final section included personal and demographic questions. Participants were asked to respond to questions regarding their age, sex, level of education, institution of teaching training, years teaching, and certification areas. Questions pertaining to the students within the observed class were posed. Questions included: number of male and female, grade level, and number of students with Individual Educational Plans (IEP). The back page of the booklet included a thank you, contact information of the researchers, and the participants assigned code to assure confidentiality.

Validity and Reliability

Validity and reliability are aspects of the classical test theory (Gall et al., 1996). Classical test theory states that observations in social science research are composed of two areas: true score and error (O = TS + E). True score is the "actual amount of the characteristic (e.g., ability, attitude, personality trait)" (p. 253). The error in the classical test theory is split into two categories: non-random/systematic and random. Non-random/systematic error is the error caused by the development of the instrument. Areas of non-random/systematic error pertain to issues in face, content, and construct validity.

Face validity refers to the instrument appearing appropriate. If the instrument measures the desired material, it is deemed to have content validity (Gall et al., 1996). Face and content validity are addressed with a "panel of experts" who review the instrument and corrections are made based on the panels suggestions. Construct validity refers to the instrument questions relating. Construct validity is typically addressed using Factor Analysis.

Reliability is an estimate of the random error (Gall et al., 1996). Intra-rater reliability is the ability of the rater to use the instrument correctly. The consistency of the rating throughout the assessments is inter-rater reliability. Error cannot be eliminated from the true score measure, but the researcher must attempt to minimize it.

Validity and Reliability – FTCB

Bloom's Taxonomy is widely accepted among the educational community as a means of categorizing behaviors into levels of cognition. The FTCB was directly derived from Bloom's Taxonomy. These two assertions led Miller (1989) to state, "The FTCB can be considered valid in light of the support generally given to Bloom's Taxonomy as a means of identifying specific behaviors in the various levels of cognition" (p. 43). Additionally, the FTCB was used and deemed valid in several other studies (Ball & Garton, 2005; Cano & Metzger, 1995; Whittington, 1991).

The rater (observer) using the FTCB is directly related to the reliability of the FTCB. For this study, one rater observed all participants. Prior to field observations, the rater viewed four video tapes of teaching episodes and rated the cognitive behaviors using the FTCB. The video tapes were then viewed two weeks later, again assessing for the cognitive behaviors to assess intra-rater reliability. The observer's average intra-rater reliability for the four tapes was calculated as .94 (Pearson correlation coefficient).

Criterion-related validity, related to the correct use of the instrument "establishes validity through a comparison with some criterion external to the test" (Wiersma, 2000, p. 301). Criterion-related validity was established by computing the coefficient of equivalence. The coefficient of equivalence is a correlation between two raters (observers) to determine the similarity of the two raters (observers) use of an instrument. For this study, the coefficient of equivalence was conducted between a researcher who had used the FTCB in previous research (observer) and the researcher (observer) in this study. The correlation was approximately .91 (Pearson correlation coefficient).

An additional concern was that if teachers were informed of the research being conducted on cognitive behavior, they may be likely to change their typical interactions. This is phenomenon referred to as the Hawthorne effect. "The Hawthorne effect is any situation in which the experimental conditions are such that the mere fact that individuals are aware of participating in an experiment, are aware of the hypothesis, or are receiving special attention improves their performance" (Gall et al., 1996, p. 475). The Hawthorne effect is directly related to external validity. To improve the external validity of the observations, teachers were informed the research was being conducted to observe classroom interactions.

Validity and Reliability – Attitude Questionnaire

The attitude questionnaire was reviewed by a panel of six experts (see Appendix G) to address content and face validity. Modifications were made to the questionnaire based on recommendations by the panel. Suggestions from the panel led to the addition, removal, and revision of questions. A pilot test, consisting of secondary teachers (n = 23) who were not in the research sample, was used to measure the reliability of the instrument. Prior to estimating the reliability, the seventeen negatively phrase questions were recoded to align with the positively phrased questions. A Cronbach's alpha conducted on the pilot test sample resulted in a reliability estimate of 0.83.

Factor Analysis was conducted on the pilot data to identify the constructs present. Pilot study data were analyzed using principle components analysis (Kim & Mueller, 1978). According to Kim and Mueller, constructs with eigenvalues less than one should not be considered. To assist in the interpretation of the factors, an orthogonal (varimax) rotation was used. Garson (n.d.) indicated that a cutoff value should be placed on a variable to be considered a defining part of a factor. A loading value of .4 can be considered weak and a value of .6 can be considered strong. For this study the suggested guidelines were used and a median value was chosen at .5. The median value was chosen in an attempt to be conservative.

Using eigenvalues of one or above, 16 factors (constructs) were found. To reduce the number of constructs 70% of the variance was set as the desired amount of explained variance (Garson, n.d.). Using the 70% of explained variance, thirty-three questions were found to be within seven constructs. The seven constructs accounted for 71% of the total variance of the questionnaire (see Appendix H). Each set of questions were placed on a separate sheet of paper for the panel of experts to review. Members of the panel were asked to review each list of questions holistically and suggest a construct name. The suggestions were compiled, resulting in (a) Internal factors of teaching higher-order thinking skills. (b) Improvement of teaching higher-order thinking skills. (c) Expectations of students. (d) Barriers to teaching higher-order thinking skills. (e) External Factors of teaching higher-order thinking skills. (f) Raising the cognitive level of current teaching. (g) Benefits from teaching higher-order thinking skills.

Data Collection

FTCB

Each teacher was observed three times between the beginning of March until the middle of May, 2005. Teacher observations were scheduled at three week intervals. This observation schedule was adapted to avoid tests, quizzes or out-of-class activities. Teachers were email one week prior to the desired observation data (see Appendix I). Teachers were asked to approve the date or indicate any conflicts. After the observation was scheduled, the teachers were sent a reminder email one day prior to the scheduled observation (see Appendix J). When possible, observations were conducted with both the agriculture and science teachers on the same site visit.

During each visit, the observer tried to reduce the Hawthorne effect with consistent behavior. The observer viewed the class from the back portion of the room to remove any potential for interaction with the teacher or students. The FTCB was used during the class. The observer used a silent timer to assist in the six minute intervals and to minimize the disruption of the class. Behaviors were recorded from the start of the class period (usually indicated by a bell) to the dismissal of the class (final bell). In circumstances where the class was moved from the classroom (library, lab, outside, etc.) the observer followed and continued the observation. Appendix K is an example of a completed FTCB from an observation.

Attitude and Demographic Characteristics

At the completion of the third observation, teachers were given a packet including a cover letter, the attitudinal questionnaire, and a self addressed, stamped envelop (Dillman, 2000). The cover letter included instructions for completing the questionnaire and return it within three days. Any non-responders were emailed a reminder notice five days after the third observation. The Missouri Department of Elementary and Secondary Education's (2005b) website was used to obtain school related information: number of students, teacher to student ratio, and percentage of students who qualified for free and reduced lunch. Data pertaining to the schools was based on 2004 school reports. Data from 2004-2005 were not available, so 2003-2004 data were used for the study.

Data Analysis

Data from the first two objectives were collected in all scales of measurement. Objective one was, describe the demographic characteristics (sex, age, years of teaching, highest degree, and certification area) of teachers. Objective two, describe the characteristics of the school (number of students, number of free and reduced lunch qualified students, and teacher to student ratio), and class demographics (number of students, number of individualized instructional plans, sex, and classification). Data representing nominal form (teacher sex, certification; student sex) were analyzed using modes, frequencies, and percentages. The remaining data for objectives one and two were interval and ratio data (teacher age, years of teaching, class size, age of students, school size, number of IEPs in class, number of students qualified for free and reduced lunch, and student to teacher ratio). For interval and ratio data, means, medians, and modes were calculated as measures of central tendency. Standard deviation and range were calculated as measures of variability.

Data to describe teachers' attitude toward teaching at higher levels of cognition, objective 3, were collected using summated rating scale questions. The summated scores were treated as interval data. Prior to summation, 17 questions were recoded from negative to positive. Measures of central tendency were reported using a mean, median, and mode. Measures of variability were reported using a standard deviation and range.

For objective four, measure the level of cognitive behavior of teachers, multiple steps were used to calculate the level of cognitive behavior for a given teacher. The frequencies observed within each level of cognition during an observation were totaled. The totals from each teacher's three observations were summed to derive a total for each level of cognition. The total from each level was then divided by the grand total of the teacher's observed behaviors, to arrive at a percentage for each cognitive level.

Miller (1989) identified studies (Newcomb & Trefz, 1987; Pickford, 1988) that justified the use of a weighting system for each level of cognition. The weighting system was justified based on the increasing complexity of Bloom's taxonomy. Miller also stated that Synthesis and Evaluation should be equally weighted due to the lack of evidence (Madaus, Woods, & Nuttall, 1973; Kropp & Stoker, 1966) for increased complexity between the two levels. The assigned weighting values for each cognitive level are displayed in Table 2. The calculated percentage for each cognitive level was multiplied by the corresponding weight value. The weighed cognitive percentages for each teacher were totaled to obtain a single cognitive behavior value. Teachers' weighted cognitive behavior had a possible range of 10 to 50.

Table 2

Cognitive Weighting Values

Level of Cognition	Value
Knowledge	.10
Comprehension	.20
Application	.30
Analysis	.40
Synthesis	.50
Evaluation	.50

Note. Miller, 1989.

The mean for each of the six levels of cognitive behavior and the total cognitive behavior were compared between agriculture teachers and science teachers for objective six (Describe the difference in the level of cognitive behavior between agriculture and science teachers.). A two-tailed independent *t*-test was used to compare the means of each of the six levels of cognition and the total cognitive behavior between agriculture teachers and science teachers. Independent *t*-tests are used to determine if two means are statistically different. Both sample means are used to compute a $t_{observed}$ value (Shavelson, 1996). The $t_{observed}$ is then compared to a $t_{critical}$ to determine the significance. Significance was set *a priori* at .05. The *t*-test was used because there were only two groups for comparison and the sample size was small (Myers & Well, 1995).

Three multiple linear regression equations were evaluated to determine the predictability of the level of cognitive behavior on the basis of attribute characteristics (objective seven). Since prediction was the goal of the regression model, a stepwise regression model was used (Pedhazur, 1997). Teachers' cognitive behavior was the dependent variable for each of the four regression models. To increase the power of the analysis, variables were combined and removed. The independent variables for the first equation were teacher characteristics (sex, age, level of education, and content area). The second regression equation included school characteristics (number of students) as the independent variables. Class variables (number of upperclassmen, number of underclassmen and number of IEPs) were the independent variables for the third regression equation. Results from the regression models were reported with R^2, the coefficient of determination. The coefficient of determination is the statistic used to describe the magnitude of the regression of dependent variable on to the independent variable. The alpha level for all statistical operations was set *a priori* at 0.05.

Institutional Review Board

Federal regulations and University of Missouri-Columbia policy require approval of all research studies that involve human subjects before investigators can begin their research. The University of Missouri-Columbia Office of Research and the Institutional Review Board (IRB) conduct this review to protect the rights and welfare of human subjects involved in biomedical and behavioral research. In compliance with the aforementioned policy, this study received proper review and was granted permission to proceed. The IRB assigned reference number 1046497 to this study to assess the cognitive behavior of secondary agriculture and science teachers.

CHAPTER IV

FINDINGS

Purpose of Study

The purpose of this study was to investigate the level (Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation) of cognitive behavior exhibited by secondary agriculture teachers, how they compare to science teachers, and what characteristics are indicators of specific cognitive behaviors. This chapter is a presentation of the results of that investigation.

Population

The target population for this study was secondary agriculture teachers in Missouri ($N = 454$). The accessible population was secondary agriculture teachers within a 50 mile radius around Columbia, Missouri who taught in a school with seven period days. Additionally, teachers who were serving as a cooperating teacher were removed from the population. In total, 53 ($N = 53$) teachers were found in schools that met the requirements. Names were drawn from the 2004-2005 teachers in-service list. To reduce bias in the selection process, all teachers within schools meeting the requirements were placed in a database and ten ($n = 10$) schools were randomly selected to participate in the study. Due to scheduling conflicts one school was removed from the sample, resulting in a sample of nine ($n = 9$) agriculture teachers.

Findings are reported in order of objective with the exception of objective five (describe how agriculture and science teachers compare by personal, school, and class characteristics). Objective five is reported concurrently with objectives one through four.

Research Objective One

Teachers responded to the demographic section of the questionnaire to complete objective one (describe the demographic characteristics of selected teachers). Table 3 summarizes nominal-level data findings. Of the nine agriculture teachers, six (66.67%) were male and three (33.33%) were female. Three levels of education were found with five (55.56%) teachers with Bachelor's, three (33.33%) Masters, and one (11.1%) Specialist degrees. Seven (77.78%) of the nine agriculture teachers were certified only in agriculture. One (11.11%) was certified in agriculture and science and one (11.11%) in agriculture, science and industrial arts.

Of the nine science teachers, six (66.67%) were female and three (33.33%) were male (Table 3). Four (44.44%) teachers had earned a Bachelor's degree and five (55.56%) earned a Masters. All (100.00%) of the science teachers held teaching certificates only in science.

Table 3

Characteristics for Nominal-level Data for Agriculture Teachers (n=9) and Science Teachers (n=9)

	Agriculture		Science	
Characteristic	Frequency	Percent	Frequency	Percent
Sex				
Male	6	66.67	3	33.33
Female	3	33.33	6	66.67
Highest Degree				
Bachelors	5	55.56	4	44.44
Masters	3	33.33	5	55.56
Specialist	1	11.11	0	0.00
Certification Area				
Agricultural Education	9	100.00	0	0.00
Science	2	22.22	9	100.00
Industrial Arts	1	11.11	0	0.00

Note. Two agriculture teachers held multiple teaching certifications.

The interval or higher-level data findings for agriculture and science teachers are presented in Table 4. For agriculture teachers, the mean age was 34.56 (*SD* = 11.06) years with average of 9.56 (*SD* = 10.20) years of teaching. The mean age of science teachers was 38.00 (*SD* = 12.83) and they taught for an average of 8.11 (*SD* = 7.64) years.

Table 4

Characteristics for Interval or Higher-Level Data for Agriculture Teachers (n=9) and Science Teachers (n=9)

Characteristic	Mean	Median	Mode	*SD*	Range (min-max)
Agriculture					
Age	34.56	32	-[a]	11.06	23-51
Years of Teaching	9.56	6	1	10.20	1-28
Science					
Age	38.00	38	26	12.83	24-57
Years of Teaching	8.11	5	1	7.64	1-21

[a] no modal value.

Research Objective Two

The second objective of this study was to describe the school (n = 9) characteristics (number of students, number of free and reduced lunch qualified students, and teacher to student ratio), and class demographics (number of students, number of individualized instructional plans, sex, and classification) associated with participants of the study.

Demographic characteristic data pertaining to student numbers within the participating schools were collected from the Missouri Department of Elementary and Secondary Education's website (2005b). Table 5 summarizes the school characteristics. The mean number of students found in the schools was 412.67 (*SD* = 289.12). An average of 23.52% (97.04, *SD* = 70.64) students qualified for free and reduced lunch. Participating schools had a mean of 18 (*SD* = 3.94) students per classroom teacher.

Table 5

Student Demographics for Observed Schools (n = 9)

School Characteristic	Mean	Median	*SD*	Range (min-max)
Number of Students	412.67	290	289.12	87-903
Number of Free and Reduced Lunch Qualified	97.04	58	70.64	17-205
Number of Students per Teacher	18.00	18	3.94	10-24

Teachers provided demographic information pertaining to students enrolled in the observed class. Agriculture classes had a mean of 13.89 (*SD* = 4.70) students per class and the science classes averaged 16.44 (*SD* = 7.45) students (Table 6). The mean number of male students in the agriculture classes was 8.22 (*SD* = 2.82) or 59.18% and 40.82% (*M* = 5.67, *SD* = 3.71) were female. Within the science classes 45.99% (*M* = 7.56, *SD* = 4.19) were male and 54.01% (*M* = 8.89, *SD* = 5.51) were female. There were no freshman enrolled in the agriculture classes, but 86.40% (*M* = 12.00, *SD* = 3.28) were sophomores, 8.78% (*M* = 1.22, *SD* = 1.71) juniors, and 4.82% (*M* = 0.67, *SD* = 1.00) seniors. The science classes had 2.01% (*M* = 0.33, *SD* = 1.00) freshman, 81.74% (*M* = 13.44, *SD* = 9.91) sophomores, 12.17% (*M* = 2.00, *SD* = 3.87) juniors, and 4.07% (*M* = 0.67, *SD* = 1.12) seniors on average enrolled. The agriculture classrooms had a mean of 2.00 (*SD* = 1.50) students with Individualized Instructional Plans (IEP) or 14.39% and in the science classrooms 14.17% (*M* = 2.33, *SD* = 3.08) of the students had IEPs.

Table 6

Student Demographics for Agriculture (n = 9) and Science Classrooms (n = 9)

	Agriculture				Science			
Student Characteristic	*M*	*SD*	%	Range (min-max)	*M*	*SD*	%	Range (min-max)
Males	8.22	2.82	59.18	4-13	7.56	4.19	45.99	2-15
Females	5.67	3.71	40.82	2-12	8.89	5.51	54.01	3-19
Freshman	0.00	0.00	0.00	0-0	0.33	1.00	2.01	0-3
Sophomores	12.00	3.28	86.40	7-16	13.44	9.91	81.74	0-30
Juniors	1.22	1.71	8.78	0-5	2.00	3.87	12.17	0-12
Seniors	0.67	1.00	4.82	0-3	0.67	1.12	4.07	0-3
IEPs	2.00	1.50	14.39	0-5	2.33	3.08	14.17	0-9
Total Students	13.89	4.70		7-20	16.44	7.45		9-30

Note. Median $_{ag\_males}$ = 8; Median $_{sci\_males}$ = 7; Median $_{ag\_females}$ = 6; Median $_{sci\_females}$ = 8; Median $_{ag\_fresh}$ = 0; Median $_{sci\_fresh}$ = 0; Median $_{ag\_soph}$ = 13; Median $_{sci\_soph}$ = 11; Median $_{ag\_jun}$ = 1; Median $_{sci\_jun}$ = 0; Median $_{ag\_sen}$ = 0; Median $_{sci\_sen}$ = 1; Median $_{ag\_iep}$ = 0; Median $_{sci\_iep}$ = 1.

Research Objective Three

A summated rating scaled questionnaire was administered to teachers to determine their attitude toward teaching at higher levels of cognition (objective three). The 50 question instrument used a six point Likert-type scale. The scale for the questions ranged from 1 (strongly disagree) to 6 (strongly agree). Mean attitude scores were dichotomized into unfavorable and favorable attitude. Teachers' total scores ranging from

1 to 3.49 were considered to be an unfavorable attitude toward teaching at higher levels of cognition. Teachers' total scores ranging from 3.50 to 6 were considered to be a favorable attitude toward teaching at higher cognitive levels. The mean attitude score for agriculture teachers was found to be 4.21 (*SD* = 0.26) (Table 7). Science teachers' mean attitude score was 4.21 (*SD* = 0.23). No statistical difference ($p > .05$) was found between the two groups of teachers. Therefore, the null hypothesis was accepted. Complete questionnaire results for agriculture teachers are found in Appendix L and results for science teachers are found in Appendix M.

Table 7

Mean Attitude Toward Teaching at Higher Levels of Cognition Score for Agriculture and Science Teachers

Teacher	*n*	Mean Attitude	*SD*	Range (min-max)	*t*	*p*
Agriculture	9	4.21	0.26	3.88-4.62	0.07	0.95
Science	9	4.21	0.23	3.82-4.44		

Note. Mode $_{ag\_att}$ = 3.88; Mode $_{sci\_att}$ = 4.36; Median $_{ag\_att}$ = 4.26; Median $_{sci\_att}$ = 4.36.

Research Objective Four

Teachers' cognitive behavior was measured by collecting three observations of each of the 18 teachers (objective four). Cognitive behavior was recorded using the 55 behavior categories on the Florida Taxonomy of Cognitive Behaviors. Each teacher's cognitive behavior across the six cognitive levels of Bloom's Taxonomy (Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation) was recorded as a percentage of the total behaviors for each of the three observations. For each observation, teachers' observed behavior at each cognitive level was subtotaled, resulting in a subtotal for each cognitive level. Subtotals for each observation were totaled for all three observations, resulting in a single measurement per cognitive level for each teacher. Additionally, the six cognitive level totals were combined into a grand total of observed cognitive behaviors for each teacher. Teacher's total number of behaviors for each cognitive level was divided by the teacher's grand total, resulting in a percentage of teacher's cognitive behavior at each level. Table 8 summarizes the mean percentage for each level of cognition at each of the three observations.

Table 8

Mean Percentages by Cognitive Level for Classroom Behavior for the Three Observations

	Agriculture (*n* = 9)			Science (*n* = 9)		
Cognitive Level	Obs. 1 *M* %	Obs. 2 *M* %	Obs. 3 *M* %	Obs. 1 *M* %	Obs. 2 *M* %	Obs. 3 *M* %
Lower-Order	84.73	93.69	65.78	86.38	76.18	87.59
Knowledge	53.33	66.94	40.60	52.17	56.82	60.46
Comprehension	31.40	26.75	25.18	34.21	19.36	27.13
Higher-Order	15.27	6.30	34.22	13.63	23.82	12.41
Application	8.35	2.61	24.44	7.77	11.09	5.23
Analysis	3.17	3.69	9.78	5.35	12.73	4.37
Synthesis	0.33	0.00	0.00	0.51	0.00	2.38
Evaluation	3.42	0.00	0.00	0.00	0.00	0.43

Knowledge-level behavior was observed 53.33, 66.94, and 40.60% of the time, for the three agriculture classroom's observations (Table 8). For observation one, teacher cognitive behaviors representing comprehension was present 31.40%, observation two 26.75%, and observation three 25.18% of the time. Analysis-level behavior was observed 3.17% for observation one, 3.69% for observation two and 9.78% for the final observation. Synthesis and evaluation were not observed during the second and third observation, but were observed 0.33 and 3.42% respectively, during the first observation. Lower-order teacher behavior (Knowledge and Comprehension) was observed 84.73% for observation one, 93.69% for observation two and 65.78% for observation three. Higher-order teacher behavior (Application, Analysis, Synthesis, and Evaluation) was observed 15.27, 6.30, and 34.22%, respectively over the three observations.

In the science classrooms, the three teacher observations yielded 52.17, 56.82, and 60.46% of knowledge behavior, respectively (Table 8). At the Comprehension level, observations resulted in 34.21, 19.36, and 27.13% of teacher behavior. Application and analysis level teacher behavior was observed 7.77 and 5.35% for the first observation, 11.09 and 12.73% for the second, and 5.23 and 4.37% for the final observation. For observation one, synthesis level teacher behavior was observed 0.51 and 2.38% for the third observation. Synthesis level teacher behavior was not observed during observation 2. The third observation was the only observation in which evaluation level teacher behavior was observed (0.43%). Lower-order teacher behavior was observed 86.38, 76.18, and 87.59%, respectively over the three observations. Higher-order teacher behavior was observed 13.63% for the first observation, 23.82% for the second observation, and 12.41% for the third observation.

The percentages for the three observations were totaled by cognitive level. In addition, the mean for each level was weighted as identified by Miller (1989) on the basis of increasing complexity of Bloom's Taxonomy. Table 9 displays the results for agriculture teachers. Knowledge level behavior was observed 52.77% of the time ranging from 44.26 to 86.27%, with a resulting cognitive weight of 5.28. With a mean of 29.75%, comprehension resulted in a cognitive weight of 5.95 with a range of 7.84 to 44.66%. Application behavior was observed an average of 10.35% of the time with a range of 0.00 to 20.63%. Application's cognitive weight was 3.10. With a range of 0.00 to 12.86%, analysis behavior resulted in 5.81% of the observations and a cognitive weight of 2.32. The cognitive weight for synthesis was 0.06 with a mean of 0.11% and a range of 0.00 to 0.97%. Evaluation behavior was found to have a mean of 1.21%, with a range of 0.00 to 6.35%, and a cognitive weight of 0.60. Lower-order behaviors (Knowledge and Comprehension) were observed 82.52% of the teacher observations. Higher-order (Application, Analysis, Synthesis, Evaluation) behavior was observed 17.48% of the teacher observation. Agriculture teachers were found to have a total cognitive behavior weight of 17.31 (*SD* = 2.12).

Table 9

Average Percent of Time of Cognitive Behavior Displayed by Level For Agriculture Teachers Mean (n = 9)

Cognitive Level	*M* %	Cum %	Range (min-max)	Weight Value	Cognitive Weight	Cum Cog Weight
Lower-Order						
Knowledge	52.77	52.77	44.26-86.27	.10	5.28	5.28
Comprehension	29.75	82.52	7.84-44.66	.20	5.95	11.23
Higher-Order						
Application	10.35	92.87	0.00-20.63	.30	3.10	14.33
Analysis	5.81	98.68	0.00-12.86	.40	2.32	16.65
Synthesis	0.11	98.79	0.00-0.97	.50	0.06	16.71
Evaluation	1.21	100.00	0.0-6.35	.50	0.60	17.31

Note. Mode $_{know}$ = 44.2; Mode $_{comp}$ = 37.7; Mode $_{app}$ = 0.0; Mode $_{ana}$ = 0.0; Mode $_{syn}$ = 0.0; Mode $_{eval}$ = 0.00; Median $_{know}$ = 47.7; Median $_{comp}$ = 29.5; Median $_{app}$ = 10.3; Median $_{ana}$ = 3.9; Median $_{syn}$ = 0.0; Median $_{eval}$ = 0.0.

The total cognitive weight for science teachers was 16.78 (*SD* = 2.40). Knowledge and Comprehension means were found to be 57.42 and 27.02% respectively (Table 10). Resulting in an average of 84.44% of the observations at lower-order behavior. Knowledge behavior had a range of 46.58 to 69.57% with a cognitive weight of 5.74. Comprehension had a range of 19.18 to 35.80% with a cognitive weight 5.40. With a range of 1.30 to 16.47% Application behavior had a mean of 6.97% and a cognitive weight of 2.09. The cognitive weight for Analysis behavior was 2.99 from a mean of

7.48% and a range of 0.86 to 23.29%. The mean percentage for Synthesis behavior was 0.96% with a range of 0.00 to 8.64%. The cognitive weight for Synthesis was 0.48. Evaluation was found to have a mean percentage of 0.16% and a range of 0.00 to 1.43% with a cognitive weight of 0.08. Higher-order (Application, Analysis, Synthesis, Evaluation) behavior was observed an average of 15.56% of the time. Individual observation data can be found in Appendix N.

Table 10

Average Percent of Time of Cognitive Behavior Displayed by Level For Science Teachers Mean (n = 9)

Cognitive Level	*M* %	Cum %	Range (min-max)	Weight Value	Cognitive Weight	Cum Cog Weight
Lower-Order						
Knowledge	57.42	56.48	46.58-69.57	.10	5.74	5.74
Comprehension	27.02	84.44	19.18-35.80	.20	5.40	11.14
Higher-Order						
Application	6.97	91.41	1.30-16.47	.30	2.09	13.23
Analysis	7.47	98.88	0.86-23.29	.40	2.99	16.22
Synthesis	0.96	99.84	0.00-8.64	.50	0.48	16.70
Evaluation	0.16	100.00	0.00-1.43	.50	0.08	16.78

Note. Mode $_{ana}$ = 4.9; Mode $_{syn}$ = 0.0; Mode $_{eval}$ = 0.0; Median $_{know}$ = 54.3; Median $_{comp}$ = 25.9; Median $_{app}$ = 6.2; Median $_{ana}$ = 4.9; Median $_{syn}$ = 0.0; Median $_{eval}$ = 0.0.

Research Objective Six

The six levels of cognitive behavior were compared to determine if agriculture and science teachers differed in their cognitive behavior. Two-tailed independent *t*-tests were used to compare the teachers' weighted cognitive scores, and significance was set *a priori* at .05. Results are displayed in Table 11. When comparing the teachers' behavior at each of the six levels of Bloom's Taxonomy, no significant ($p > .05$) differences were found by level of cognition. At the Knowledge and Comprehension cognitive levels, *t*-values were 0.92 ($p = .37$) and 0.64 ($p = .53$), respectively. The *t*-values at the application and analysis cognitive levels were 1.15 ($p = .27$) and 0.58 ($p = .57$), respectively. The *t*-value for the synthesis cognitive level was found to be 0.88 ($p = .39$) and evaluation was 1.27 ($p = .24$). For comparison, Knowledge and Comprehension were combined into a variable called lower-order thinking, and Application, Analysis, Synthesis, and Evaluation were combined into a variable called higher-order thinking. Agriculture teachers had a lower-order thinking weighted mean of 11.23 (*SD* = 1.45). Science teachers were found to have a weight mean of 11.14 (*SD* = 1.54). The *t*-value for lower-order thinking was 0.12 ($p = .91$). Agriculture teachers were found to have a higher-order thinking weighted mean of 6.08 (*SD* = 2.70). Science teachers' higher-order thinking weighted mean was 5.64 (*SD* = 3.86). The *t*-value for higher-order thinking was 0.29 ($p = .78$). No significant differences ($p > .05$) were found by lower or higher-order thinking. Therefore, the null hypothesizes were accepted.

Table 11

Comparison of Teachers Weighted Cognitive Scores for the Six Levels of Cognition by Teacher Type

	Agriculture (n=9)		Science (n=9)			
Cognitive Level	Mean	*SD*	Mean	*SD*	*t*	*p*
Knowledge	5.28	1.34	5.74	0.73	0.92	.37
Comprehension	5.95	2.26	5.40	1.19	0.64	.53
Application	3.10	2.16	2.09	1.53	1.15	.27
Analysis	2.32	1.99	2.99	2.81	0.58	.57
Synthesis	0.06	0.16	0.48	1.44	0.88	.39
Evaluation	0.60	1.22	0.08	0.24	1.27	.24
Lower-Order[a]	11.23	1.45	11.14	1.54	0.12	.91
Higher-Order[b]	6.08	2.70	5.64	3.86	0.29	.78

Note. Weighted cognitive scores; [a] Knowledge + Comprehension; [b] Application + Analysis + Synthesis + Evaluation.

Table 12 summarizes the comparison of teachers' total cognitive behavior. The significance level was set *a priori* at .05. The total cognitive behavior of agriculture and science teachers was not significantly different. The mean weighted cognitive behavior for agriculture teachers was 17.31 (*SD* = 2.12). Science teachers had a mean cognitive weight of 16.78 (*SD* = 2.40) The two-tailed independent *t*-test resulted in a value of 0.50 and a *p*-value of .63. Based on this analysis the null hypothesis was accepted.

Table 12

Comparison of Teachers' Total Weighted Cognitive Behavior by Teacher Type

Teacher Type	n	M	SD	t	p
Agriculture	9	17.31	2.12	0.50	.63
Science	9	16.78	2.40		

Research Objective Seven

To determine the predictability of the teachers' level of cognitive behavior, on the basis of attribute characteristics a multiple linear regression was conducted. In an attempt to meet the basic regression assumption that the dependent and independent variables must be related, a bivariate intercorrelation analysis was conducted. Analysis was completed using Pearson's (r) and Point-Biserial (r_{pb}) correlations (Table 13). Age was found to have a substantial, negative (Davis, 1971) relationship with sex (r_{pb} = -.53) and a substantial relationship with level of education (r_{pb} = .53) The relationship between age and years of experience was found to be very high (r_{pb} = .82). Age was also found to have a negligible negative relationship with attitude (r_{pb} = -.05) and total teacher cognitive behavior (r = -.01). Sex was found to have a low negative relationship with level of education (r_{pb} = -.23), and total cognitive behavior (r = -.26). A moderate negative relationship was found between sex and years of teaching experience (r = -.43). A low relationship was found between sex and attitude (r_{pb} = .11). A negligible relationship was present between level of education and years of experience (r_{pb} = .05). A low relationship was found between level of education and attitude (r_{pb} = .20). Cognitive behavior and level of education had a low negative relationship (*r* = -.26). There was a low, negative relationship between years of experience and attitude (r_{pb} = -.28) and negligible negative relationship between years of experience and total teacher cognitive behavior (*r* = -.05). The relationship between attitude toward teaching at higher levels of cognition and teachers' total cognitive behavior was found to be substantial (*r* = .51).

Table 13

Bivariate Intercorrelations Among Agriculture Teacher Characteristics and Total Cognitive Behavior

Characteristic	Sex	Education	Years of Experience	Attitude	Cognitive Behavior
Age	-.53	.53	.82	-.05	-.01
Sex		-.23	-.43	.11	-.26
Education			.05	.20	-.26
Years of Experience				-.28	-.05
Attitude					.51

Note. Sex Coding: Male = 0, Female = 1.

The small sample size of the study was deemed a potential problem in the power of the analysis (Cohen & Cohen, 1983). In an attempt to increase the power (the ability to identify differences when present) of the regression model, variables were eliminated and/or combined. Years of experience (*r* = -.05) and teacher's age (*r* = -.01) were both found to be negligibility correlated with total cognitive behavior (Davis, 1971). It was deemed that negligible relationships did not exhibit sufficient evidence of a relationship. Due to the regression assumption that the independent and dependent variable must be related, years of experience and age were removed from consideration in the regression analysis.

To better understand the amount of total variance in total teacher cognitive behavior that can be explained by the selected characteristics (sex, level of education, and attitude), an enter method linear regression was conducted (Table 14). The $F_{(3,5)}$ value for the model was found to be 2.27 and was not significant ($p > .05$). The Coefficient of determination ($R^2 = .58$; Adjusted $R^2 = .32$) indicated that 58% of the variance in total teacher cognitive behavior can be explained by the four independent variables.

Table 14

Regression of Total Cognitive Behavior on Teacher Characteristics (n = 9)

Variable	R	R^2	b	t	p
Characteristic	.76	.58			
Sex			-1.88	-1.46	.20
Education			-1.43	-1.59	.17
Attitude			0.11	2.19	.08
Constant			-2.11	-0.21	.84

Note. Adjusted $R^2 = .32$; For Model $F_{(3,5)} = 2.27$; Sex Coded: Male = 0, Female = 1; Education Coded: Bachelors = 0, Masters or Above = 1.

A stepwise regression was conducted to create a prediction model. The null hypothesis was: Teacher characteristics will not predict teachers' level of cognitive behavior. The stepwise model was unable to create a prediction equation using teacher characteristics. Resulting in the acceptance of the null hypothesis

Pearson's product-moment bivariate intercorrelations were calculated between the school characteristics and total teacher cognitive behavior. The total number of students in the school was found to have very high correlations with the number of students qualified for free and reduced lunch (r_{pb} = .90) and the student to teacher ratio (r_{pb} = .81). The relationship between total students and total teacher cognitive behavior was moderate (r = .33). Students qualified for free and reduced lunch was very highly correlated with student to teacher ratio (r_{pb} = .75) and moderately correlated with total teacher cognitive behavior (r = .37). Student to teacher ratio and total teacher cognitive behavior were moderately (r = .49) related.

Table 15

Bivariate Intercorrelation Among School Characteristics and Total Agriculture Teacher Cognitive Behavior (n = 9)

Characteristics	Free & Reduced Qualified Students	Student to Teacher Ratio	Teacher Cognitive Behavior
Total Students	.90	.81	.33
Free & Reduced Qualified Students		.75	.37
Student-Teacher Ratio			.49

An enter method regression model was conducted to better understand the amount of variance in total teacher cognitive behavior as explained by school characteristics (total students, free & reduced qualified students, and student-teacher ration). Student-teacher ratio was very highly correlated with the other two independent variables and student-teacher ratio was found to have the highest correlation with total teacher cognitive behavior. Therefore, to increase the power of the regression model, student-teacher ratio was the only independent variable used. The coefficient of determination (R^2 = .24; Adjusted R^2 = .13) for the regression model indicates that the model can explain 24% of the total variance of the total teacher cognitive behavior from selected school characteristic (Table 16). The model was not significant with a $F_{(1,7)}$ value of 2.17 (p > .05).

Table 16

Regression of Total Agriculture Teacher Cognitive Behavior on Total Student in the School (n = 9)

Variable	R	R^2	b	t	p
Characteristic	.49	.24			
Student-Teacher Ratio			0.26	1.47	.18
Constant			12.59	3.85	.01

Note. Adjusted R^2 = .13; For Model $F_{(1,7)}$ = 2.17.

The null hypothesis was tested using the stepwise regression model. Stepwise regression can be used to find a prediction equation. The null hypothesis was: School characteristics will not predict teachers' level of cognitive behavior. The stepwise model was unable to create a prediction of total teacher cognitive behavior using the student to teacher ratio in the school. The null hypothesis was accepted.

A bivariate intercorrelation among classroom characteristics and total agriculture teacher cognitive behavior was conducted (Table 17). To assist in increasing power for the regression analysis, the number of freshmen and sophomores were combined and labeled as *underclassmen*, and juniors and seniors were combined and labeled as *upperclassmen*. Thus, reducing four variables into two. Number of females and number of males in the class were found to have a negligible relationship (r_{pb} = .02). Females were substantially related to number of underclassman (r_{pb} = .51) in the class. Number of females in the class was found to be very highly correlated to number of upperclassmen (r = .86) in the class. Number of students with IEPs and number of females was found to have a low relationship (r_{pb} = .16). Total agriculture teacher cognitive behavior and number of females was found to be moderately correlated (r = .42). Number of males was found to be very highly correlated with underclassmen (r_{pb} = .76), but was found to have a low correlation with upperclassmen (r_{pb} = .13). The relationship between males and number of students with IEPs in the class was moderate (r_{pb} = .44). Number of males and total agriculture teacher cognitive behavior was found to have a low relationship (r = .27). Number of upperclassmen and underclassmen were found to be moderately related (r_{pb} = .35). Underclassmen was found to have a low relationship with number of students with IEPs (r_{pb} = .25). Total teacher cognitive behavior and number of underclassmen were found to have a low relationship (r = .30). Number of upperclassmen was found to have a moderate relationship with number of students with IEPs (r_{pb} = .41). Number of upperclassmen and total agriculture teachers cognitive behavior were substantially related (r = .56). Finally, number of students with IEPs was found to have a low relationship with total agriculture cognitive behavior (r = .15).

In an attempt to increase the power of the regression model, selected characteristics were eliminated. Number of females was removed from consideration in the regression analysis because it was very highly correlated with upperclassmen (r_{pb} =

.86) and upperclassmen had a higher correlation (r = .56) with total agriculture teacher cognitive behavior. Number of males was also removed from consideration because of the very high correlation with number of underclassmen (r_{pb} = .79). Additionally, underclassmen had a higher correlation with total agriculture teacher cognitive behavior (r = .30) than did number of males (r = *.27)*.

Table 17

Bivariate Intercorrelations Among Classroom Characteristics and Total Agriculture Teacher Cognitive Behavior (n = 9)

Characteristic	Males	Underclassmen	Upperclassmen	IEPs	Cognitive Behavior
Females	.02	.51	.86	.16	.42
Males		.79	.13	.44	.27
Underclassmen			.35	.25	.30
Upperclassmen				.41	.56
IEPs					.15

Note. Underclassmen = Freshmen & Sophomores; Upperclassmen = Juniors & Seniors.

To better understand the amount of variance in total teacher cognitive behavior that can be explained by the selected classroom characteristics, an enter method linear regression was conducted. The coefficient of determination (R^2 = .34; Adjusted R^2 = -.06) indicated that 34% of the total variance in total teachers' cognitive behavior can be explained by the selected classroom characteristics (number of underclassmen, number of upperclassmen, and number of students with IEPs). The model was not found to be significant ($F_{(3,8)}$ = 0.85; p > .05).

Table 18

Regression of Total Agriculture Teacher Cognitive Behavior on Selected Classroom Characteristics (n = 9)

Variable	R	R^2	b	t	p
Characteristic	.58	.34			
Underclassmen			0.08	0.33	.76
Upperclassmen			0.50	1.36	.23
IEPs			-0.16	-0.28	.79
Constant			15.70	5.25	.01

Note. Adjusted R^2 = -.06; For Model $F_{(3,5,)}$ = 0.85; Underclassmen = Freshmen & Sophomores; Upperclassmen = Juniors & Seniors.

A stepwise regression was conducted to test the null hypothesis. The null hypothesis was: Class characteristics will not predict teachers' level of cognitive behavior. The stepwise regression model was unable to create a prediction equation for total cognitive behavior using classroom characteristics. Therefore, the null hypothesis was accepted.

CHAPTER V

SUMMARY, CONCLUSION, IMPLICATIONS, AND RECOMMENDATIONS

This chapter is a summary of the design methods, theoretical bas, and findings of this study, it also presents conclusions, implications, and recommendations based on the findings.

Purpose of the Study

The purpose of this study was to investigate the level of cognitive behavior exhibited by secondary agriculture teachers, how they compare to science teachers, and what characteristics are indicators of specific cognitive behaviors.

Research Objectives

For this study the following research objectives were used to address the problem and guide the study:

1. Describe the demographic characteristics (sex, age, years of teaching, highest degree, and certification area) of selected teachers.
2. Describe the characteristics of the schools (number of students, number of free and reduced lunch qualified students, and teacher to student ratio), and demographics of the classes (number of students, number of individualized instructional plans, sex, and classification).
3. Describe teachers' attitude toward teaching at higher levels of cognition.

a. H_o: There is no difference in attitude toward teaching at higher levels of cognition between agriculture and science teachers (H_o: $\mu_{ag} = \mu_{sci}$).

4. Measure the level of cognitive behavior of teachers.
5. Describe how agriculture and science teachers compare by personal, school, and class characteristics.
6. Describe the difference in the level of cognitive behavior between agriculture and science teachers.

    a. H_o: There is no difference in each of the six levels of cognitive behavior and lower and higher level behavior between agriculture teachers and science teachers ($H_{o\,(1\text{-}8)}$: $\mu_{ag} = \mu_{sci}$; 1= knowledge, 2 = comprehension, 3 = application, 4 = analysis, 5 = synthesis, 6 = evaluation, 7 = lower-order, 8 = higher-order).
    b. H_o: There is no difference in mean cognitive behavior scores between agriculture teachers and science teachers (H_o: $\mu_{ag} = \mu_{sci}$).

7. Determine the predictability of the level of teachers' cognitive behavior on the basis of attribute characteristics.

    a. H_o: Teacher characteristics (sex, age, years of teaching, highest degree, content area, and attitude) will not predict teachers' level of cognitive behavior (H_o: $R^2 = 0$).
    b. H_o: School characteristics (number of students, percentage of free and reduced lunch qualified students, and teacher to student ratio) will not predict teachers' level of cognitive behavior (H_o: $R^2 = 0$).

c. H_o: Class characteristics (number of individualized instructional plans, sex, and age) will not predict teachers' level of cognitive behavior (H_o: $R^2 = 0$).

Limitations of the Study

The sample of the study was limited based on location. Therefore, the sample is not representative of the population. Caution should be exercised when generalizing the results beyond the sample. The presence of an observer could alter the normal behavior of the subjects. Gall, Borg, and Gall (1996) indicate the presence of an observer can affect the typical classroom behavior of the subjects.

Research Design

The design of this study was descriptive-correlational. Gall et al. (1996, p. 757) define descriptive research as, "A type of investigation that measures the characteristics of a sample or population on pre-specified variables." In this study, the predictability of teachers' cognitive behavior, on the basis of their characteristics was examined. Correlational, or predictive, research is to predict a phenomenon from existing information (Gall et al.). Although used often in social science research, correlational research is only as good as the existing information. Gall et al. indicate that relationships can be due to unknown measured variables, such as underlying variables or biased raters. To fully explain correlations, experimental research must be conducted.

Variables of Interest

Cognitive behavior is the teacher's personal conduct leading to conscious mental activity (Merriam-Webster Dictionary, 1997) and was measured using the Florida Taxonomy of Cognitive Behavior (FTCB). Attitude toward teaching at higher-levels of cognition was measured using a 50 question summated rating scale questionnaire. Attitude was determined based on the teachers' level of agreement to the 50 questions. Teachers' personal and professional characteristics (age, sex, years of teaching, highest degree, and certification areas) were self-reported on the questionnaire. Also collected on the questionnaire were selected classroom characteristics (number of female student, number of male students, number of students with Individualized Educational Plans (IEPs) and the students' classification). Selected school characteristics (total number of students, percentage of free & reduced lunch qualified students and student to teacher ratio) were collected from the website of the Missouri Department of Elementary and Secondary Education (2005b). School numbers were for the 2003-2004 school year, and were compiled from schools' annual reports.

Population

The target population for this study was secondary agriculture teachers in Missouri ($N = 454$). The accessible population was secondary agriculture teachers within a 50 mile radius around Columbia, Missouri who taught in a school with seven period days. Teachers who were serving as a cooperating teacher were removed from the population. In total, 53 ($N = 53$) teachers were found in schools that met the requirements. Names were drawn from the 2004-2005 teachers' in-service list.

To reduce bias in the selection process, all teachers within schools meeting the requirements were placed in a database and ten (*n* = 10) schools were randomly selected to participate in the study. Agriculture teachers within each selected school who taught agricultural science II were contacted by the researcher. Teachers were contacted by phone to investigate their interest in participating in the study. To assure that each teacher received the same information, a written script (see Appendix A) was used. If the agriculture teachers agreed to participate, he/she were asked to identify a biology teacher within their school system. For comparison purposes, the identified biology teacher at each school was contacted to investigate their willingness to participate. A written script (see Appendix B) was also used with the science teachers when contacting them by phone. Agriculture teachers were not used without a cooperating science teacher. Following positive interest from both the agriculture and science teachers, the school's administrator was called to seek permission. A written script (see Appendix C) was also used with the administrator to insure consistent communication of information. After verbal permission was granted, the administrator was sent an official letter of participation (see Appendix D). Schools in which either teacher (agriculture or science), or the administrator declined to participate were removed from further consideration. Replacement subjects were randomly selected from the remainder of the assessable population. Due to scheduling conflicts during data collection, one agriculture teacher was removed from the sample, resulting in a sample of nine (*n* = 9) subjects.

Instrumentation

For the purposes of this study, two data collection instruments were used: the Florida Taxonomy of Cognitive Behaviors, and an attitudinal questionnaire.

Cognitive Behavior

Collection of the level of the teacher's classroom cognitive behavior was obtained using the Florida Taxonomy of Cognitive Behaviors (FTCB) (Brown, Ober, Soar & Webb, 1968). The FTCB (See Appendix E) was developed based on Bloom's Taxonomy, but the two are not identical (Miller, 1989). Bloom (1956) identified six major levels of cognition while the FTCB recognizes seven levels (Miller, 1989). The FTCB recognizes Knowledge, Translation, Interpretation, Application, Analysis, Synthesis, and Evaluation. Within the FTCB, the levels of Translation and Interpretation are aligned with Bloom's Comprehension level. The four upper levels of both taxonomies are similar: Application, Analysis, Synthesis, and Evaluation.

Attitude and Demographics

To collect data related to demographic data and attitude toward teaching at higher levels of cognition, a questionnaire adapted from Whittington (1991) was used. Changes and additions to the questionnaire design were made in accordance with Dillman's (2000) *Tailored Design Method.* The first section of questions related to the teachers attitude. Teacher demographic information was collected in the second section followed by the class demographics. Attitude toward teaching at higher levels of cognition was assessed using 50 summated rating scale questions. Each of the 50 questions consisted of a statement and a six-point scale of agreement. Participants were asked to read each statement and indicate their level of agreement (1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = slightly agree, 5 = moderately agree, 6 = strongly agree).

The final section included personal and demographic questions. Participants were asked to respond to questions regarding their age, sex, level of education, institution of teaching training, years teaching, and certification areas. Questions pertaining to the students within the observed class were posed. Questions included: number of male and female, grade level, and number of students with Individual Educational Plans (IEP). The back page of the booklet included a thank you, contact information of the researchers, and the participants assigned code to assure confidentiality.

Validity and Reliability

Validity and reliability are aspects of the classical test theory (Gall et al., 1996). Classical test theory states that observations in social science research are composed of two areas: true score and error (O = TS + E). True score is the "actual amount of the characteristic (e.g., ability, attitude, personality trait)" (p. 253). The error in the classical test theory is split into two categories: non-random/systematic and random. Non-random/systematic error is the error caused by the development of the instrument. Areas of non-random/systematic error pertain to issues in face, content, and construct validity.

Face validity refers to the instrument appearing appropriate. If the instrument measures the desired material, it is deemed to have content validity (Gall et al., 1996). Face and content validity are addressed with a panel of experts who review the instrument and corrections are made based on the panels suggestions. The panel of experts, six individuals, is selected from experts in the field of study. Construct validity refers to the instrument questions relating. Construct validity is typically addressed using factor analysis. Reliability is an estimate of the random error (Gall et al.,). Intra-rater reliability is the ability of the rater to use the instrument correctly. The consistency of the rating throughout the assessments is inter-rater reliability. Error cannot be eliminated from the true score measure, but the researcher must attempt to minimize it.

Validity and Reliability – FTCB

Bloom's Taxonomy is widely accepted among the educational community as a means of categorizing behaviors into levels of cognition. The FTCB was directly derived from Bloom's Taxonomy. These two assertions led Miller (1989, p. 43) to state, "the FTCB can be considered valid in light of the support generally given to Bloom's Taxonomy as a means of identifying specific behaviors in the various levels of cognition." Additionally, the FTCB was used and deemed valid in several other studies (Ball & Garton, 2005; Cano & Metzger, 1995; Whittington, 1991).

The rater (observer) using the FTCB is directly related to the reliability of the FTCB. For this study, one rater observed all participants. Prior to field observations the rater viewed four video tapes of teaching episodes and rated the cognitive behaviors using the FTCB. The video tapes were then viewed two weeks later, again assessing for the cognitive behaviors to assess intra-rater reliability. The observer's average intra-rater reliability for the four tapes was calculated as .94 (Pearson correlation coefficient). Criterion-related validity, related to the correct use of the instrument, "establishes validity through a comparison with some criterion external to the test" (Wiersma, 2000, p. 301). Criterion-related validity was established by computing the coefficient of equivalence. The coefficient of equivalence is a correlation between two raters (observers) to determine the similarity of the two raters (observers) use of an instrument. For this study, the coefficient of equivalence was conducted between a researcher who had used the FTCB in previous research (observer) and the researcher (observer) in this study. The correlation was approximately .91 (Pearson correlation coefficient).

An additional concern was that if teachers were informed of the research being conducted on cognitive behavior, they may be likely to change their typical interactions. This is referred to as the Hawthorne Effect. "The Hawthorne Effect is any situation in which the experimental conditions are such that the mere fact that individuals are aware of participating in an experiment, are aware of the hypothesis, or are receiving special attention improves their performance" (Gall et al., 1996, p. 475). The Hawthorne Effect is directly related to external validity. To improve the external validity of the observations, teachers were informed the research was being conducted to observe classroom interactions.

Validity and Reliability – Attitude Questionnaire

The attitude questionnaire was reviewed by a panel of six experts to address content and face validity. Modifications were made to the questionnaire based on the panel's recommendations. Suggestions from the panel led to the addition, removal, and revision of questions. A pilot test consisting of secondary teachers (n = 23) who were not in the research sample were used to measure the reliability of the instrument. Prior to estimating the reliability, the seventeen negatively phrase questions were recoded to align with the positively phrased questions. The Cronbach's alpha procedure conducted on the pilot test sample resulted in a reliability estimate of 0.83.

Factor Analysis was conducted on the pilot data to identify the constructs present. Pilot study data were analyzed using principal components analysis (Kim & Mueller, 1978). According to Kim and Mueller, constructs with eigenvalues less than one should not be considered. To assist in the interpretation of the factors, an orthogonal (varimax) rotation was used. Garson (n.d.) indicated that a cutoff value should be placed on a variable to be considered a defining part of a factor. A loading value of .4 can be considered weak and a value of .6 can be considered strong. For this study the suggested guidelines were used and a median value was chosen at .5. The median value was chosen in an attempt to be conservative.

Using eigenvalues of one or above, 16 factors (constructs) were found. To reduce the number of constructs 70% of the variance was set as the desired amount of explained variance (Garson, n.d.). Using the 70% of explained variance, thirty-three questions were found to be within seven constructs. The seven constructs accounted for 71% of the total variance of the questionnaire. Each set of questions were placed on a separate sheet of paper for the panel of experts to review. The panel was asked to review each list of questions holistically and suggest a construct name. The suggestions were compiled, resulting in the following construct titles: (a) Internal factors of teaching higher-order thinking skills; (b) Improvement of teaching higher-order thinking skills; (c) Expectations of students; (d) Barriers to teaching higher-order thinking skills; (e) External Factors of teaching higher-order thinking skills; (f) Raising the cognitive level of current teaching; (g) Benefits from teaching higher-order thinking skills.

Data Collection

FTCB

Each teacher was observed three times between the beginning of March until the middle of May, 2005. Teacher observations were scheduled at three week intervals. The observation schedule was adapted to avoid tests, quizzes, or out of class activities. Teachers were email one week prior to the desired observation data. Teachers were asked to approve the date or indicate any conflicts. After the observation was scheduled, the teachers were sent a reminder email one day prior to the scheduled observation. When possible, observations were conducted with both the agriculture and science teachers on the same site visit.

During each visit, the observer tried to reduce the Hawthorne Effect with consistent behavior. The observer viewed the class from the back portion of the room to remove any potential for interaction with the teacher or students. The FTCB was used during the class. The observer used a silent timer to assist in the six-minute intervals and to minimize the disruption of the class. Behaviors were recorded from the start of the class period (usually indicated by a bell) until dismissal of the class (final bell). In circumstances where class was moved from the classroom (library, lab, outside, etc.), the observer followed and continued the observation. Appendix I is an example of the form used to record the observed behaviors.

Attitude and Demographic Characteristics

At the completion of the third observation, teachers were given a packet including a cover letter, the attitudinal questionnaire, and a self addressed, stamped envelop (Dillman, 2000). The cover letter included instructions that instructed teachers complete the questionnaire and return it within three days. Any non-responders were emailed a reminder notice five days after the third observation. The Missouri Department of Elementary and Secondary Education's (2005b) website was used to obtain school related information: number of students, teacher to student ratio, and percentage of students who qualified for free and reduced lunch. Data pertaining to the schools were based on 2004 school reports. Data from 2004-2005 were not available, 2003-2004 data were used from the study.

Data Analysis

Objective one which was to describe the demographic (sex, age, years of teaching, highest degree, and certification area) characteristics teachers and objective two describe the characteristics of the school (number of students, number of free and reduced lunch qualified students, and teacher to student ratio) and class demographics (number of students, number of individualized instructional plans, sex, and classification) were collected in all scales of measurement. Data representing nominal form (teacher sex, certification; student sex) were analyzed using modes, frequencies, and percentages. The remaining data for objectives one and two were interval and ratio data (teacher age, years of teaching, class size, age of students, school size, number of IEPs in class, number of students qualified for free and reduced lunch, and student to teacher ratio). For interval and ratio data, means, medians, and modes were calculated as measures of central tendency. Standard deviation and range were calculated as measures of variability.

Data to describe teachers' attitude toward teaching at higher levels of cognition, objective 3, were collected using summated rating scale questions. The summated scores were treated as interval data. Prior to summation, 17 questions were recoded from negative to positive. Measures of central tendency were reported using a mean, median, and mode. Measures of variability were reported using a standard deviation and range. Comparison of the agriculture and science teachers' attitude was conducted using a two-tailed independent *t*-test. An independent *t*-test was used to determine if two means are statistically different. The sample means were used to compute a t_{observed} value (Shavelson, 1996). The t_{observed} is then compared to a t_{critical} to determine the significance. Significance was set *a priori* at .05. The *t*-test was used because there were only two groups for comparison and the sample size was small (Myers & Well, 1995).

For objective four which was to measure the level of cognitive behavior of teachers, multiple steps were used to calculate the level of cognitive behavior for a given teacher. The frequencies observed within each level of cognition during an observation were totaled. The totals from each of the teacher's three observations were summed to derive a total for each level of cognition. The total from each level was then divided by the grand total of the teacher's observed behaviors to arrive at a percentage for each cognitive level.

Miller (1989) identified studies (Newcomb & Trefz, 1987; Pickford, 1988) that justified the use of a weighting system for each level of cognition. The weighting system was justified based on the increasing complexity of Bloom's taxonomy. Miller also proposed that Synthesis and Evaluation should be equally weighted due to the lack of evidence (Madaus, Woods, & Nuttall, 1973; Kropp & Stoker, 1966) for increased complexity between the two levels. The assigned weighting values for each cognitive level are displayed in Table 2. The calculated percentage for each cognitive level was multiplied by the corresponding weight value. The weighed cognitive percentages for each teacher were totaled to obtain a single cognitive behavior value. Teachers' weighted cognitive behavior had a possible range of 10 to 50.

The mean for each of the six levels of cognitive behavior and the total cognitive behavior were compared between agriculture teachers and science teachers for objective five (Describe the difference in the level of cognitive behavior between agriculture and science teachers.). A two-tailed independent *t*-test was used to compare the means of each of the six levels of cognition and the total cognitive behavior between agriculture teachers and science teachers. Independent *t*-tests were used to determine if two means are statistically different. Both sample means were used to compute a t_{observed} value (Shavelson, 1996). The t_{observed} was then compared to a t_{critical} to determine the significance. Significance was set *a priori* at .05. The *t*-test was used because there were only two groups for comparison and the sample size was small (Myers & Well, 1995).

Three multiple linear regression equations were evaluated to determine the predictability of the level of cognitive behavior on the basis of attribute characteristics (objective six). Since prediction was the goal of the regression model, a stepwise regression model was used (Pedhazur, 1997). Teachers' cognitive behavior was the dependent variable for each of the four regression models. To increase the power of the analysis, variables were combined and removed. The independent variables for the first equation were teacher characteristics (sex, age, level of education, and content area). The second regression equation included school characteristics (number of students) as the independent variables. Class variables (number of upperclassmen, number of underclassmen and number of IEPs) were the independent variables for the third regression equation. Results from the regression models was reported with R^2, the coefficient of determination. The coefficient of determination is the statistic used to describe the magnitude of the regression of dependent variable on to the independent variable. The alpha level for all statistical operations was set *a priori* at 0.05.

Summary of Findings

Findings are summarized by order of objective, with the exception of objective five which can be found throughout the discussion of objectives one through four.

Research Objective One

Agriculture teachers were 67% (6) male and 33% (3) female. Five (56%) agriculture teachers had earned a bachelor's degree, three (33%) a master's, and one (11%) had earned a specialist degree. One (11%) agriculture teacher was certified in agriculture, science and industrial arts. Another (11%) agriculture teacher was dual certified in agriculture and science, and seven (78%) were certified solely in agriculture. All (100%) of the science teachers were certified only in science. The agriculture teachers had a mean of 9.56 (*SD* = 10.20) years of teaching experience and averaged 34.56 (*SD* = 11.06) years of age.

The science teachers were an average of 38.00 (*SD* = 12.83) years of age and had a mean of 8.11 (*SD* = 7.64) years of teaching experience. Four (44%) of the science teachers had earned a bachelor's degree and five (56%) held a master's. The science teachers were 33% (3) male and 67% (6) female.

Research Objective Two

The schools averaged 412.67 (*SD* = 289.12, Range 87-903) students with 23.52% qualified for free and reduced lunch (*M* = 97.04, *SD* = 70.64, Range 17-205). The schools had a mean of 18.00 (*SD* = 3.94, Range 10-24) students per teacher. The agriculture classrooms averaged 13.89 (*SD* = 4.70, Range 7-20) students and there were 16.44 (*SD* = 7.45, Range 9-30) students in the science classrooms. Within the agriculture classrooms, 59.18% (*M* = 8.22, *SD* = 2.82) of the students were male and 40.82% (*M* = 5.67, *SD* = 3.71) were female. The science classrooms were 45.99% (*M* = 7.56, *SD* = 4.19) male and 54.01% (*M* = 8.89, *SD* = 5.51) female. The average agriculture classroom had no freshman, but 86.40% (*M* = 12.00, *SD* = 3.28) were sophomores, 8.78% (*M* = 1.22, *SD* = 1.71) juniors, and 4.82% (*M* = 0.67, *SD* = 1.00) seniors. For the students in the average science classroom, 2.01% (*M* = 0.33, *SD* = 1.00) were freshman, 81.74% (*M* = 13.44, *SD* = 9.91) were sophomores, 12.17% (*M* = 2.00, *SD* = 3.87) were juniors, and 4.07% (*M* = 0.67, *SD* = 1.12) were seniors. Students with Individualized Educational Plans made up 14.39% (*M* = 2.00, *SD* = 1.50) of the agriculture classes and 14.17% (*M* = 2.33, *SD* = 3.08) of the science classes.

Research Objective Three

With a range of 194-231, the agriculture teachers had a mean attitude toward teaching at higher levels of cognition of 210.33 (*SD* = 12.22). The science teachers had a range of 191-222, resulting in a mean attitude score of 210.72 (*SD* = 11.29). No statistical difference was found between the two groups.

Research Objective Four

When reviewing the findings of the percentage of each level of cognition over the three observations, several trends were observed. Agriculture teachers had an overall decrease in Knowledge and Comprehension from observation one to three. Science teachers also had a reduction in Comprehension, but an increase in Knowledge. Application and Analysis level behavior by science teachers decreased overall during the three observations, but both levels were at their highest during the second observation. In the agriculture classrooms, Application and Analysis increased overall, but Application was at its lowest during the second observation. Synthesis and Evaluation were present during the first observation with agriculture teachers, but were not observed during the second and third visits. For science teachers, Synthesis increased from observation one to three but was not observed during the second observation. Evaluation was not observed during the first two observations in the science classrooms, but was observed during the third.

The three observations were combined to find the mean percentage of each level and the cognitive weight for the two groups. Agriculture teachers were found to have a total cognitive weighted value of 17.31. The mean percentage of Knowledge found in the classroom was 52.77, a range of 44.26 to 86.27%, and a weighted value of 5.28. Comprehension had a range of 7.84 to 44.66%, a mean of 29.75%, and a weighted value of 5.95. Lower-order thinking (Knowledge and Comprehension), was present 82.52% of the time. With a weighted value of 3.10, Application was observed 10.35% (Range 0.0-20.63%) of the time. Analysis had a mean of 5.81% (Range 0.0-12.86) and a weighted value of 2.32. Synthesis was found to have a range of 0.0 to 0.97% and a mean of 0.11%. Synthesis had total cognitive weight of 0.06. Evaluation had a mean of 1.21% (Range 0.0-6.4) and a weighted value of 0.60.

The mean of lower-order (Knowledge and Comprehension) cognitive behavior for science teachers was found to be 84.44%. Knowledge was found to have a mean of 57.42% (Range 45.58-69.57%) and a cognitive weight of 5.74. With a mean of 27.02% and a range of 19.18 to 35.80%, Comprehension had a cognitive weight of 5.40. Application was observed 6.97% of the time with a range of 1.30 to 16.47% and a cognitive weight of 2.09. The cognitive weight for analysis was 2.99 from a mean of 7.47% and a range of 0.86 to 23.29%. Synthesis and Evaluation had cognitive weights of 0.48 and 0.08, respectively. Synthesis was found to have a mean of 0.96 and a range of 0.0 to 8.64%. The mean for Evaluation was 0.16% with a range of 0.0 to 1.43%. The total cognitive weight value for science teachers was 16.78.

Research Objective Six

The comparison of the six levels of cognition, between agriculture and science teachers, resulted in no significant difference. The t-value for knowledge was 0.92 (p = .37). Comprehension was found to have a t-value of 0.64 (p = .53). Application and analysis had t-values of 1.15 (p = .27) and 0.58 (p = .57). Synthesis was found to have a t-value of 0.88 (p = .39). The t value for Evaluation was 1.27 with a p value of .24. Lower and higher-order thinking were also compared. Lower-order thinking resulted in a t-value of 0.12 (p = .91). The t-value for higher-order thinking was found to be 0.29 (p = .78). Neither lower nor higher-order thinking were significantly different for agriculture and science teachers. Total cognitive behavior for the two groups was also compared and resulted in a t-value of 0.50 and a p-value of .63.

Research Objective Seven

As a step to multiple linear regression, bivariate intercorrelations were conducted to better understand the relationship within each category of independent variables (teacher characteristics, class characteristics, and school characteristics) and total cognitive behavior of agriculture teachers. In an attempt to increase the power of the regression analysis, independent variables within each category were combined and/or eliminated. Enter method regression models were conducted to understand the amount of variance in total agriculture teachers' cognitive behavior that can be explained by selected teacher characteristics, accounted for 58% (R^2 = .58). Selected school characteristics accounted for 24% (R^2 = .24), and selected class characteristics accounted for 34% (R^2 = .34) of the variance in total teacher cognitive behavior. No predication equations were found using the stepwise regression model, for any of the three categories.

Conclusions and Implications

Conclusions: Research Objective One

The average agriculture teaching in this study was male, 34.5 years of age and 9.5 years of teaching experience. In addition, the majority of the agriculture teachers held a bachelor's degree and were certified to teach only agriculture.

Implications: Research Objective One

The average years of teaching, degrees, and certification areas would imply that the sample represented varying levels of experience. The level experience and education implies that the teachers in the study exhibit common behaviors.

Conclusions: Research Objective Two

The schools included in the study had a mean student population of 413 students with approximately 23.5% eligible for free and reduced lunch. According to the Missouri Department of Elementary and Secondary Education (2005b), the state average enrollment for schools with grades nine through twelve and agriculture is 507, making the schools selected for use in this study less populous than the state average. Additionally, the Missouri Department of Elementary and Secondary Education (2005a) reported that the average school with grades nine through twelve and agriculture in Missouri had approximately 33% of students eligible for free and reduced lunch. The difference could be attributed to the fact that the schools observed were within fifty miles or less of cities with industry and institutions of higher education in the study. The smaller communities might be serving as "bedroom communities" for those who travel to the larger city for their higher paying employment, resulting in a slightly higher socioeconomic standard for the school system. The schools also averaged 18 students per teacher, slightly lower than the state average in schools with agriculture (19.1) (Missouri Department of Elementary and Secondary Education, 2005a).

In the classrooms observed, the average agriculture student was a male sophomore. According to the Missouri Department of Elementary and Secondary Education (n.d., Secondary Agricultural Education in the Public Schools section), “Of the students enrolled [in agricultural education], over 30% are female.” In the schools selected 41% of the students in agriculture were female, slightly more than the figure reported for all schools. The number of students with individualized educational plans was found to be 14.4%

Implications: Research Objective Two

The characteristics of the schools and classrooms in the study were similar to the nine through twelfth grade schools with agriculture state averages, but not equal. Caution should be taken when generalizing beyond the accessible population, teachers in Central Missouri.

Conclusions: Research Objective Three

It is concluded from the data that agriculture teachers have favorable attitudes toward teaching at higher levels of cognition ($M = 4.21$). Summated totals at or above 3.50 are considered favorable attitudes toward teaching at higher levels. The lowest score was found to be 3.88, indicating that none of the teachers had an unfavorable attitude.

Implications: Research Objective Three

All teachers had a slightly favorable attitude toward teaching at higher levels of cognition. It could be assumed from the slightly favorable attitude score that instruction in the classrooms will not vary as much as teachers with more positive attitudes. An attitude score that is only slightly favorable could have implications toward pre-service and in-service needs. Instruction on the importance of higher level instruction should a positive impact on teachers' attitudes toward teaching at higher cognitive levels.

Conclusions: Research Objective Four

Overall, agriculture teachers had a reduction in cognitive behavior in the Knowledge and Comprehension levels over the three observations. The opposite trend in cognitive behavior can be seen in the Application and Analysis levels. Synthesis and Evaluation cognitive behavior decreased over the three observations of the agriculture teachers. Agriculture teachers exhibit lower-order (Knowledge and Comprehension) behavior the vast majority of the time (83%). These conclusions are consistent with Cano and Metzger (1995) who found that secondary horticulture teachers taught at lower-levels 84% of the time. At the college level, lower-order has been found 61% (Ball & Garton, 2005), 98% (Whittington, 1995), and 80% (Whittington, Stup, Bish, & Allen, 1997).

Implications: Research Objective Four

Arguably the months of March, April, and May is not the best time of the year to measure the teaching of agriculture teachers, due to the high number of out of school activities (FFA convention, state and district events, track and golf meets, etc). If cognitive behavior is predominately at lower-levels during this time, it could be due to the time of year. The same study conducted in the fall might have different outcomes.

Conclusions: Research Objective Five

Agriculture and science teachers were similar in most selected personal characteristics with the exception of sex. The majority of agriculture teachers were male, while the majority of science teachers were female. Students in the observed classes were similar between the two types of teachers except for the gender make-up of the students and total number of students in the class. Science classroom average about two more students with the majority being female, where as agriculture classes had a majority of male students. Agriculture and science teachers, statistically and practically, had the same attitude toward teaching at higher levels of cognition.

When teachers' cognitive behavior was compared over the three observations, agriculture teachers' lower-order cognitive behavior increased for the second observation with a reduction in the third observation. In contrast, science teachers' lower-order cognitive behavior decrease for the second observation but increase during the third observation. The weighted cognitive behavior for each level and the weighted total cognitive teacher behavior was not practically different between the two types of teachers.

Implications: Research Objective Five

The similarity of teachers and the classrooms they taught in implies the two groups were well suited for comparison. The pattern of lower-order cognitive behavior over the three observations was different between the two groups and may be due to the high frequency of seasonal FFA activities for the agriculture teachers and their students. Although the patterns of cognitive teacher behavior over the three observations were different, the total cognitive teacher behavior was not, indicating that students are receiving similar experiences in subject areas.

Conclusions: Research Objective Six

The cognitive weighted behavior of agriculture and science teachers, in each of the six levels of cognition, was not statistically different. Additionally, the total cognitive weighted behavior was not significantly different between agriculture and science teachers. Agriculture and science teachers are not exhibiting different cognitive behaviors in agricultural science II and biology.

Implications: Research Objective Six

Biology and Agricultural Science II were compared because of the similar biological science content in each course. The teaching of the content specific to agricultural education tends to have potential for reaching higher levels of cognition. If agriculture teachers do not utilize the potential opportunities to increase higher-order thinking, the future of agricultural education could be at question. If cognitive behavior is not different between the two programs, what is the cognitive advantage of having them both?

Johnson, Wardlow, and Franklin (1997) found that hands-on activities did not significantly increase cognitive achievement, but Wenglinsky (2000) reported a positive relationship. Activities such as research papers and cooperative learning groups have been found to increase higher-order thinking (Herrington & Oliver, 1999; McGregor, 1994). Wenglinsky (2000, p. 8) found that students whose teachers had “received professional development in higher-order thinking skills outperformed their peer.” These findings, in combination with the findings of this study, imply that if teachers are going to help students develop cognitively, they must use different activities and become involve in professional development opportunities.

Conclusions: Research Objective Seven

The three null hypothesizes were accepted. H_{o1}: Teacher characteristics (sex, age, years of teaching, highest degree, content area, and attitude) will not predict teachers’ level of cognitive behavior (H_o: $R^2 = 0$); H_{o2}: School characteristics (number of students, number of free and reduced lunch qualified students, and teacher to student ratio) do not predict teachers’ level of cognitive behavior (H_o: $R^2 = 0$); H_{o3}: Class characteristics (number of individualized instructional plans, sex, and age) do not predict teachers’ level of cognitive behavior (H_o: $R^2 = 0$).) The acceptance of the three hypothesizes indicates that, with the information collected, agriculture teachers’ cognitive behavior cannot be predicted. Other factors and characteristics must be collected to better understand the presage and context variables that may influence cognitive behavior. These findings may in-part be due to the small sample size used in this study.

Implications: Research Objective Seven

Increasing the number of teachers in the sample may assist in the prediction of total teacher cognitive behavior. Higher-order teacher cognitive behavior may not be present in the development of a teacher, therefore not present in the teachers’ classroom behavior. If the experiences of teachers are modified to include instruction or development on cognitive behavior, the behavior might become predictable.

Recommendations

1. Based on teachers' classroom cognitive behavior secondary agriculture teachers should increase the cognitive level of instruction. "Only through thinking can your change whatever it is about you life that needs changing. Only through thinking can you take command of you future" (Elder & Paul, 2004, p. 6). Paul and Elder (2004a) stated that "instructors must design activities and assignments that require students to think actively within the concepts and principles of the subject" (Introduction section). Agriculture should be a vehicle to learn not only content, but also thinking.
2. Teachers should reflect and discuss with students their higher-level cognitive behavior to assist in the development of students' higher-order thinking skills. Newcomb, McCraken, Warmbrod, and Whittington (2004) stated that material must have meaning. If students are to learn higher-order thinking skills, the students must understand the meaning of the skills. Specifically, identifying the skills and their purpose will assist in transferring these skills to other situations and contexts. In addition, student must be aware of their progress (Newcomb, et al.). Teachers should not only connect the behavior but also assist the students in understanding their success.
3. In-service instruction of higher-level behavior should be developed and conducted. If higher-order thinking is a goal of secondary education (Beyer, 1987;

Dewey, 1933; Missouri Department of Elementary and Secondary Education, 1999; The National Commission of Excellence in Education, 1983), then the development and support of teachers' abilities to develop students' thinking skills should be the goal of teacher preparation programs. This recommendation is supported by Cano and Metzger (1995), who concluded continuing education pertaining to teaching higher-order thinking should be included in in-service training. This recommendation is also supported by Whittington (1998) who found that intervention with professors increased higher-level discourse. Additionally, it has been supported that professional development of teachers can influence student performance (Wenglinsky, 2000).

4. To increase pre-service teachers' cognitive behavior and favorable attitude, teacher development programs should include instruction in and about higher-level cognitive teacher behaviors. Ball and Garton (2005) found that teacher development professors are not modeling higher-level behavior. To help pre-service teachers understand higher-level cognitive behaviors, they should be exposed to it in teacher development courses.

Recommendations for Further Research

1. Given the limited generalizability of the sample, the study should be replicated. With each additional replication, a better understanding of secondary cognitive behavior will develop. Additionally, replication should occur at different times of the school year to understand the condition apart from the normal FFA distractions of the spring semester.

2. The relationship between teachers' cognitive behavior and students' cognitive development should be studied further. Wenglinsky (2000) found support for improved student performance based on conveying higher-order thinking, but higher-order thinking of the student was not a variable his only variable was achievement. If teachers are expected to display higher-order behavior, a link to students' cognitive development should be made.
3. Experimental design should be used to explore the impact of teaching strategies on teachers' cognitive behavior and student cognitive achievement. Treatment groups can be trained to teach with specific teaching strategies. A control group can be used to compare against it. A pre-test post-test cognitive assessment can be used to explore student outcomes and the FTCB can be used to measure the teachers' cognitive behavior.
4. The influence of pre-service instruction about cognitive behavior and development on classroom behavior should be studied. If teachers' professional development on higher-order thinking can improve student performance (Wenglinsky, 2000), then pre-service instruction might have the same impact.
5. Experimental design should be used to better understand what professional development procedure has the most impact on secondary teachers' cognitive behavior. Whittington (1998) used three treatment groups to explore the impact of professional development. A control group could be added to understand if change occurs without intervention.
6. Research has been conducted to link teachers' objectives, classroom behavior, and assessment at the college level (Ball & Garton, 2005; Whittington, 1991) and at

the secondary level (Cano & Newcomb, 1990). Additional research should be conducted to understand the present condition of secondary agriculture and science teachers' objectives, behavior, and assessments.

7. With the continued recommendations for increasing the teaching of higher-order thinking skills, research should be conducted to determine what level of teaching is needed. Federal initiatives, state policies, and educational leaders have suggested an increase in students' higher-order thinking skills, but it is not known how much instruction students need.
8. The Florida Taxonomy of Cognitive Behaviors (FTCB) was developed in 1968. Students, teachers and education have changed since the development of this instrument. Investigation should occur to determine if the FTCB can be further improved.
9. The attitude toward teaching at higher-levels of cognition questionnaire was created originally in 1991. Work should be done to determine if the instrument can be further improved based on new findings and theories since its development.

APPENDICIES

Appendix A

Agricultural Education Teacher Phone Script

Hello Mr/Mrs ___________________

I am Jonathan Ulmer at the University of Missouri-Columbia, Agricultural Education Department. I am preparing to study the cognitive discourse of high school agriculture and science teachers.

Your school was selected as a potential study sight. I would like to visit your agricultural science II class three times this semester. I would sit out of the way in the class and observe. During the observation I would take a few notes. The observations will be scheduled so a typical class can be observed. My visits will occur about every three weeks. Also, at the conclusion of the third visit I would like you complete a questionnaire relating to the study.

The primary goal of the study is to better understand current instruction, it would be my pleasure to share my observations with you after the project is complete.

You need to know that this is totally voluntary and will remain confidential. The University's Institutional Review Board has reviewed and approved this study.

I will also be contacting the biology teacher to observe them as well. If both you and the biology teacher agree I will contact the administrator of the school to ask for permission from them as well.

Would you be willing to allow me to observe your class?

Who in your school system teaches biology?

Which administrator do you recommend I contact?

What time of day is the best time to contact you?

What is your email address?

When does your Ag Science II class meet?

Do you have any questions I can answer for you at this time?

Thank you for you time and I look forward to observing your class. I will be emailing you after I have talked with your administrator about scheduling an observation time.

Appendix B

Science Teacher Phone Script

Hello Mr/Mrs ___________________

I am Jonathan Ulmer at the University of Missouri-Columbia, Agricultural Education Department. I am preparing to study the cognitive discourse of high school agriculture and science teachers.

Your school was selected as a potential study sight. I would like to visit your biology class three times the semester. I would sit out of the way in the class and observe. During the observation I would take a few notes. The observations will be scheduled so a typical class can be observed. My visits will occur about every three weeks. Also, at the conclusion of the third visit I would like you complete a questionnaire relating to the study.

The primary goal of the study is to better understand current instruction, it would be my pleasure to share my observations with you after the project is complete.

You need to know that this is totally voluntary and will remain confidential. The University's Institutional Review Board has reviewed and approved this study.

I have also contacted the agriculture teacher to observe them. I will contact your school administrator to ask for permission from them as well.

Would you be willing to allow me to observe your class?

Which administrator do you recommend I contact?

What time of day is the best time to contact you?

What is your email address?

When does your biology class meet?

Do you have any questions I can answer for you at this time?

Thank you for you time and I look forward to observing your class. I will be emailing you after I have talked with the agriculture teacher and your administrator about scheduling an observation time.

Appendix C

School Administrator Phone Script

Hello Mr/Mrs ___________________________

I am Jonathan Ulmer at the University of Missouri-Columbia, Agricultural Education Department. I am preparing to study the cognitive discourse of high school agriculture and science teachers. Both Mr/Mrs. _________________ and Mr/Mrs _______________ have agree to participate, but I will not include them unless you approve their participation.

Their involvement would mean that I would observe them three times this semester. I will place myself out of the way and take notes. The observations will be scheduled so a typical class can be observed. My visits will occur about every three weeks. I would also like to either audio or video tape the class incase I miss something.

The information collected will be confidential and participation is voluntary. The University Institutional Review board has reviewed this study and approved it.

The major goal of this study is to improve teacher instruction. Should the teachers like feedback at the conclusion of the study I would be happy to supply it for them. I would also be willing to meet with you at the end of the study to discuss my findings.

Do you have any questions?

Can I observe Mr/Mrs ______________________ and Mr/Mrs ___________________?

If yes: Thank you, I will send you an official letter of participation shortly.

To help you keep track of my observations I will carbon copy you on the emails I use to schedule times with the teachers. Could you give me your email address?

If no: If you would like me to give you time to consider study participation, I would be happy to do that. What would be an appropriate time for me to call so we could discuss this further?

If still no: I appreciate your consideration of the study.

Thank you very much for your time.

Appendix D

School Participation Letter

July 14, 2005

«AddressBlock»

«GreetingLine»

Upon receiving approval from each person at your school, you have been officially included in the study being conducted by the University of Missouri-Columbia. I would like to take this opportunity to thank you for your willingness to assist with our project. With your assistance it is my sincere hope we will help the instruction of teachers in Missouri and across the country.

I would like to remind you that I will schedule three observations of your «Class» class. I will place myself in a location that will be unobtrusive. It is my sincere hope I am able to observe a typical class. The observations will be conducted at approximately three week intervals. At the conclusion of the third observation I will ask you to complete a questionnaire. Should you have any questions please contact me at your convenience.

We want you to be assured that your observations are completely confidential and will be released only in summaries in which no individual's answers can be identified. We would like to remind you that this study is completely voluntary. If you feel you cannot or should not be included in the study, please contact me as soon as possible at JonathanUlmer@mizzou.edu While completing the questionnaire, you are not required to answer all questions. If there is a questions you feel you should not or do not want to answer, please skip that question and move on to the next. If you have any question regarding your rights as a participant you may contact the University of Missouri-Columbia Institutional Review Board at 483 McReynolds Hall or (573) 882-9585. Also, be aware the primary investigator will maintain copies of all pertinent information related to the study, included but not limited to, video and audio tapes, instruments, copies of written informed consent agreements, and any other supportive documents for a period of three (3) years from the date of completion of the research.

Please complete and return the attached written consent form.

Thank you once again. I will be in contact very soon to schedule my observations.

Sincerely,

Jonathan Ulmer
Graduate Student
Agricultural Education
University of Missouri-Columbia
JonathanUlmer@mizzou.edu
(573) 884-7561

Dr. Bobby Torres
Associate Professor
Agricultural Education
University of Missouri-Columbia
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Appendix E

Florida Taxonomy of Cognitive Behaviors

FLORIDA TAXONOMY OF COGNITIVE BEHAVIOR

1.1 Knowledge of Specifics

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

1.2 Knowledge of ways and means of dealing with specifics

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

1.3 Knowledge of universals and abstracts

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

2.0 Translation

18. Restates in own words or briefer terms
19. Gives concrete examples of an abstract idea
20. Verbalizes from a graphic representation
21. Translates verbalization into graphic form
22. Translates fig. statements into lit. statements
23. Translates foreign lang. into Eng. or vice versa

3.0 Interpretation

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

4.0 Application

30. Applies previous learning to new situations
31. Applies principle to new situation
32. Applies abstract know. in a practical situation
33. Identifies, selects, and carries out a process

5.0 Analysis

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

6.0 Synthesis (Create)

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

7.0 Evaluation

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

Appendix F

Attitude Toward Teaching at Higher Levels of

Cognition Questionnaire

Cognition

Cognition relates to conscious mental activity. Typically, six levels of cognition are identified: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. Commonly referred to as Bloom's Taxonomy, the levels are hierarchal and increasingly complex. Knowledge and Comprehension are commonly considered lower-order thinking, while Application, Analysis, Synthesis, and Evaluation are grouped as higher-order thinking.

PART I

DIRECTIONS: For each of the following items, please indicate the degree to which you agree or disagree by circling one of the numbers following each statement.

Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
1	2	3	4	5	6

1.	It takes more time than it is worth to increase the cognitive level of my teaching.	1	2	3	4	5	6
2.	I enjoy opportunities for increasing the cognitive level of my teaching.	1	2	3	4	5	6
3.	I want to teach in a way that allows students to see higher levels of thinking exhibited.	1	2	3	4	5	6
4.	I would like to know more about teaching at higher cognitive levels.	1	2	3	4	5	6
5.	Teaching at the higher cognitive levels requires too much advanced preparation.	1	2	3	4	5	6
6.	Teachers need to encourage students to practice higher level thinking.	1	2	3	4	5	6
7.	Students can get the knowledge they need from high school by memorizing.	1	2	3	4	5	6
8.	Freshman level students cannot be taught at higher levels of cognition.	1	2	3	4	5	6
9.	It is important for teachers to assist students in developing higher level thinking skills.	1	2	3	4	5	6
10.	Higher level teaching is critical to the permanent learning of students.	1	2	3	4	5	6
11.	I am frustrated about teaching at higher cognitive levels.	1	2	3	4	5	6
12.	Teachers need to assist students in transferring material to different contexts.	1	2	3	4	5	6
13.	The quality of students at the undergraduate level allows for higher cognitive level teaching.	1	2	3	4	5	6
14.	Teachers present too much material at the evaluating level of cognition.	1	2	3	4	5	6
15.	I want to teach toward higher cognitive levels.	1	2	3	4	5	6
16.	Teachers' teaching objectives should be written to challenge students at higher cognitive levels.	1	2	3	4	5	6

Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
1	2	3	4	5	6

17. I am willing to devote more time to grade assignments designed to assess at higher cognitive levels.	1	2	3	4	5	6
18. I intend to substantially revise my current cognitive level of teaching.	1	2	3	4	5	6
19. My subject matter does not lend itself to higher cognitive level teaching.	1	2	3	4	5	6
20. Teachers encourage too much memorization.	1	2	3	4	5	6
21. The nature of lower level classes does not require higher cognitive level teaching.	1	2	3	4	5	6
22. Students will operate at the cognitive level at which I expect them to operate.	1	2	3	4	5	6
23. Large classes do not lend themselves to methods which reflect teaching toward higher cognitive levels.	1	2	3	4	5	6
24. Modeling higher level thinking in class will not influence students to think at higher levels.	1	2	3	4	5	6
25. Students are willing to do more than memorize.	1	2	3	4	5	6
26. It is the responsibility of the students to take information from class and use it at higher cognitive levels.	1	2	3	4	5	6
27. I am willing to spend more time on certain topics to teach them at higher cognitive levels.	1	2	3	4	5	6
28. It is important for students to be able to process information.	1	2	3	4	5	6
29. Students should be given more opportunities to exercise creativity.	1	2	3	4	5	6
30. Teachers do not have the extra time needed to teach across different levels of cognition.	1	2	3	4	5	6
31. Students, in my courses, generally are not mentally ready to be challenged at higher cognitive levels.	1	2	3	4	5	6
32. Any subject matter can be taught at higher cognitive levels.	1	2	3	4	5	6
33. Getting students to evaluate is an important goal of higher cognitive level teaching.	1	2	3	4	5	6
34. Students will develop more life-long learning skills if they are taught to create.	1	2	3	4	5	6

Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
1	2	3	4	5	6

35. I try to teach students to develop new ideas, products, or processes.	1	2	3	4	5	6
36. Application activities are a low priority when I plan.	1	2	3	4	5	6
37. Skills in evaluating will prove to be valuable to students.	1	2	3	4	5	6
38. Students in my course deserve to be challenged at higher cognitive levels.	1	2	3	4	5	6
39. I try to teach students to process the information that I present.	1	2	3	4	5	6
40. I receive recognition by my co-workers for accomplishing higher cognitive level teaching.	1	2	3	4	5	6
41. The cognitive level(s) at which I teach is adequate.	1	2	3	4	5	6
42. I could teach at higher levels of cognition, but choose not to.	1	2	3	4	5	6
43. As I teach at higher cognitive levels, I expect to see students thinking at higher cognitive levels.	1	2	3	4	5	6
44. The higher the academic level of the course, the higher the cognitive level at which the course should be taught.	1	2	3	4	5	6
45. I try to teach students to analyze.	1	2	3	4	5	6
46. I would need assistance in order to teach at higher levels of cognition.	1	2	3	4	5	6
47. I have to be patient to nurture higher level thinking among students.	1	2	3	4	5	6
48. Students complain too much when they are taught at higher levels of cognition.	1	2	3	4	5	6
49. I teach students to separate fact from opinion.	1	2	3	4	5	6
50. Students will develop more life-long learning skills if they are taught to evaluate.	1	2	3	4	5	6

PART II: DEMOGRAPHICS AND CLASS INFORMATION

DIRECTIONS: The following questions are to help us better understand you and your class. Please respond to them to the best of your knowledge.

Circle or fill in the blank with the appropriate answer.

51. What is your current age? ______

52. What is your gender?
    a. Female
    b. Male

53. What is your highest level of education?
    a. Bachelors
    b. Masters
    c. Specialist
    d. Doctoral

54. At which institution(s) did you receive your teaching training?

____

____

55. Including this year, how many years have you been teaching? ______

56. List the academic areas you are certified to teach. ____

57. What is the number of students in the observed class?
    Female: ________
    Male: ________

58. How many students of each grade level were in the observed class?
    Freshman: ________
    Sophomore: ________
    Junior: ________
    Senior: ________

59. What is the number of students with Individualized Educational Plans in the observed class? _________

Appendix G

Panel of Experts

Panel of Experts

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Appendix H

Questionnaire Construct Factor Loadings

Table H1

Factor Loadings for Factor Analysis of the Attitudinal Questionnaire

	Component						
Question	1	2	3	4	5	6	7
Question 3	.87						
Question 8	.76						
Question 10	.75						
Question 6	.74						
Question 9	.70						
Question 7	.67						
Question 17	.55						
Question 13		.90					
Question 27		.84					
Question 4		.63					
Question 37		.58					
Question 28		.51					
Question 22			.91				
Question 29			.77				
Question 25			.67				
Question 30			.63				
Question 21				.90			
Question 24				.63			
Question 5				.59			
Question 23				.57			
Question 50				.53			
Question 40					-.84		
Question 36					.72		
Question 19					.67		
Question 45					-.61		
Question 41						-.82	
Question 46						-.65	
Question 12						.60	
Question 39						.56	
Question 49							-.84
Question 34							.73
Question 47							-.54
Question 43							-.53

Appendix I

Teacher Observation Scheduling Email

Ms. Smith and Mr. Brown,

I would like to schedule my third and final observation. Would you both be available for me to observe on Friday, April 29? Please let me know by Friday if this date will work for both of you.

Thank you and I look forward to hearing from you soon.

Jon

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Appendix J

Teacher Observation Reminder Email

Ms. Smith and Mr. Brown,

I just wanted to remind you that I would be visiting Friday in Biology and Agri-Science II. If it becomes a problem, please email me on Thursday or call my cell phone 573-999-xxxx.

Thank you and see you Thursday.

Jon

Jonathan D. Ulmer
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Appendix K

Sample Coding of Instructor Behavior

Observation: 11-B-1

1.1 Knowledge of Specifics

0	6	12	18	24	30	36	42	48	54	
										1. Reads
										2. Spells
					X					3. Identifies something by name
		X			X					4. Defines meaning of a term
X		X								5. Gives a specific fact
										6. Tells about an event

1.2 Knowledge of ways and means of dealing with specifics

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

1.3 Knowledge of universals and abstracts

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

2.0 Translation

										18. Restates in own words or briefer terms
	X									19. Gives concrete examples of an abstract idea
										20. Verbalizes from a graphic representation
		X		X	X	X				21. Translates verbalization into graphic form
										22. Translates fig. statements into lit. statements
										23. Translates foreign lang. into Eng. or vice versa

3.0 Interpretation

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

4.0 Application

			X			X				30. Applies previous learning to new situations
										31. Applies principle to new situation
										32. Applies abstract know. in a practical situation
										33. Identifies, selects, and carries out a process

5.0 Analysis

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

6.0 Synthesis (Creativity)

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

7.0 Evaluation

54. Evaluates something from evidence

55. Evaluates something from criteria

Level of Cognition	Frequency of Observation	Percentage of Teaching
Knowledge	6	27.27
Comprehension	13	59.09
Application	2	9.09
Analysis	0	0.00
Synthesis	1	4.55
Evaluation	0	0.00
Total	22	100.00

Appendix L

Agriculture Teachers' Mean Scores and Frequencies by Item for the Attitude Toward Teaching at Higher Levels of Cognition Questionnaire

Table I1

Means and Frequencies by Item for Attitude Toward Teaching at Higher Cognitive Levels as Reported by Agriculture Teachers (n=9)

			Responses											
			Strongly Disagree		Moderately Disagree		Slightly Disagree		Slightly Agree		Moderately Agree		Strongly Agree	
Item	*X*	*SD*	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
It is important for students to be able to process information.	5.67	0.5	0	0	0	0	0	0	0	0	3	33.33	6	66.67
I want to teach in a way that allows students to see higher levels of thinking exhibited.	5.44	0.53	0	0	0	0	0	0	0	0	5	55.56	4	44.4
The higher the academic level of the course, the higher the cognitive level at which the course should be taught.	5.44	0.53	0	0	0	0	0	0	0	0	5	55.56	4	44.44
I want to teach toward higher cognitive levels.	5.33	0.5	0	0	0	0	0	0	0	0	6	66.67	3	33.33
I enjoy opportunities for increasing the cognitive level of my teaching.	5.22	0.44	0	0	0	0	0	0	0	0	7	77.78	2	22.22
Teachers need to encourage students to practice higher level thinking.	5.22	1.64	1	11.11	0	0	0	0	0	0	2	22.22	6	66.67
I try to teach students to develop new ideas, products, or processes.	5.22	0.67	0	0	0	0	0	0	1	11.11	5	55.56	3	33.33
Students in my course deserve to be challenged at higher cognitive levels.	5.22	0.67	0	0	0	0	0	0	1	11.11	5	55.56	3	33.33
Students complain too much when they are taught at higher levels of cognition.	5.22	1.39	0	0	1	11.11	0	0	1	11.11	1	11.11	6	66.67
I would like to know more about teaching at higher cognitive levels.	5.11	0.6	0	0	0	0	0	0	1	11.11	6	66.67	2	22.22

Continued on next page

Table I1 continued

Item	X	SD	Strongly Disagree		Moderately Disagree		Slightly Disagree		Slightly Agree		Moderately Agree		Strongly Agree	
			f	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Higher level teaching is critical to the permanent learning of students.	5.11	1.62	1	11.11	0	0	0	0	0	0	3	33.33	5	55.56
Teachers' teaching objectives should be written to challenge students at higher cognitive levels.	5.11	0.78	0	0	0	0	0	0	2	22.22	4	44.44	3	33.33
I try to teach students to process the information that I present.	5.11	0.33	0	0	0	0	0	0	0	0	8	88.9	1	11.11
It is important for teachers to assist students in developing higher level thinking skills.	5	1.58	1	11.11	0	0	0	0	0	0	4	44.44	4	44.44
Students should be given more opportunities to exercise creativity.	5	0.71	0	0	0	0	0	0	2	22.22	5	55.56	2	22.22
Students will develop more life-long learning skills if they are taught to evaluate.	5	0.71	0	0	0	0	0	0	2	22.22	5	55.56	2	22.22
Students are willing to do more than memorize.	4.89	0.78	0	0	0	0	0	0	3	33.33	4	44.44	2	22.22
Students will develop more life-long learning skills if they are taught to create.	4.89	0.78	0	0	0	0	0	0	3	33.33	4	44.44	2	22.22
Skills in evaluating will prove to be valuable to students.	4.89	0.78	0	0	0	0	0	0	3	33.33	4	44.44	2	22.22
As I teach at higher cognitive levels, I expect to see students thinking at higher cognitive levels.	4.89	0.6	0	0	0	0	0	0	2	22.22	6	66.67	1	11.11

Continued on next page

Table I1 continued

			Responses											
			Strongly Disagree		Moderately Disagree		Slightly Disagree		Slightly Agree		Moderately Agree		Strongly Agree	
Item	*X*	*SD*	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
I have to be patient to nurture higher level thinking among students.	4.89	0.78	0	0	0	0	0	0	3	33.33	4	44.44	2	22.22
Teachers need to assist students in transferring material to different contexts.	4.78	0.83	0	0	0	0	0	0	4	44.44	3	33.33	2	22.22
I am willing to spend more time on certain topics to teach them at higher cognitive levels.	4.78	0.67	0	0	0	0	0	0	3	33.33	5	55.56	1	11.11
Getting students to evaluate is an important goal of higher cognitive level teaching.	4.67	0.5	0	0	0	0	0	0	3	33.33	6	66.67	0	0
I try to teach students to analyze.	4.67	1.12	0	0	0	0	2	22.22	1	11.11	4	44.44	2	22.22
Teachers do not have the extra time needed to teach across different levels of cognition.	4.56	1.69	0	0	2	22.22	0	0	1	11.11	3	33.33	3	33.33
Any subject matter can be taught at higher cognitive levels.	4.44	1.33	0	0	1	11.11	1	11.11	2	22.22	3	33.33	2	22.22
I teach students to separate fact from opinion.	4.44	0.88	1	11.11	0	0	0	0	4	44.44	3	33.33	1	11.11
It is the responsibility of the students to take information from class and use it at higher cognitive levels.	4.33	0.87	0	0	0	0	2	22.22	2	22.22	5	55.56	0	0
The quality of students at the undergraduate level allows for higher cognitive level teaching.	4.22	1.2	0	0	1	11.11	1	11.11	3	33.33	3	33.33	1	11.11

Continued on next page

Table I1 continued

			Responses											
			Strongly Disagree		Moderately Disagree		Slightly Disagree		Slightly Agree		Moderately Agree		Strongly Agree	
Item	*X*	*SD*	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Students will operate at the cognitive level at which I expect them to operate.	4.22	1.3	0	0	1	11.11	1	11.11	4	44.44	1	11.4	2	22.22
I intend to substantially revise my current cognitive level of teaching.	4	0.71	0	0	0	0	2	22.22	5	55.56	2	22.22	0	0
Large classes do not lend themselves to methods which reflect teaching toward higher cognitive levels.	4	1.12	0	0	1	11.11	2	22.22	2	22.22	4	44.44	0	0
I am frustrated about teaching at higher cognitive levels.	3.78	1.3	0	0	1	11.11	4	44.44	1	11.11	2	22.22	1	11.11
Teachers encourage too much memorization.	3.78	1.09	0	0	1	11.11	3	33.33	2	22.22	3	33.33	0	0
The cognitive level(s) at which I teach is adequate.	3.67	0.5	0	0	0	0	3	33.33	6	66.67	0	0	0	0
I am willing to devote more time to grade assignments designed to assess at higher cognitive levels.	3.44	1.24	1	11.11	1	11.11	1	11.11	5	55.56	1	11.11	0	0
Teaching at the higher cognitive levels requires too much advanced preparation.	3.33	1.23	0	0	3	33.33	2	22.22	2	22.22	2	22.22	0	0
Teachers present too much material at the evaluating level of cognition.	3.33	1.12	0	0	2	22	4	44.44	1	11.11	2	22.22	0	0
I would need assistance in order to teach at higher levels of cognition.	3.33	1.12	0	0	2	22.22	4	44.44	1	11.11	2	22.22	0	0

Continued on next page

Table I1 continued

			Responses											
			Strongly Disagree		Moderately Disagree		Slightly Disagree		Slightly Agree		Moderately Agree		Strongly Agree	
Item	*X*	*SD*	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
The nature of lower level classes does not require higher cognitive level teaching.[a]	3.25	1.17	0	0	3	37.5	1	12.5	3	37.5	1	12.5	0	0
I receive recognition by my co-workers for accomplishing higher cognitive level teaching.	3.11	0.93	0	0	2	22.22	5	55360	1	11.11	1	11.11	0	0
I could teach at higher levels of cognition, but choose not to.	3	0.71	2	0	2	22.22	5	55.56	2	22.22	0	0	0	0
Students, in my courses, generally are not mentally ready to be challenged at higher cognitive levels.	2.89	1.27	1	11.11	3	33.33	2	22.22	2	22.22	1	11.11	0	0
It takes more time than it is worth to increase the cognitive level of my teaching.	2.78	1.2	1	11.11	3	33.33	3	33.33	1	11.11	1	11.11	0	0
Modeling higher level thinking in class will not influence students to think at higher levels.	2.67	1.12	1	11.11	4	44.44	1	11.11	3	33.33	0	0	0	0
Students can get the knowledge they need from high school by memorizing.	2	1.12	4	44.44	2	22.22	2	22.22	1	11.11	0	0	0	0
My subject matter does not lend itself to higher cognitive level teaching.	2	0.71	2	22.22	5	55.56	2	22.22	0	0	0	0	0	0
Application activities are a low priority when I plan.	2	0.71	2	22.22	5	55.56	2	22.22	0	0	0	0	0	0
Freshman level students cannot be taught at higher levels of cognition.	1.33	0.71	7	77.78	1	11.11	1	11.11	0	0	0	0	0	0

Note. [a] $n = 8$.

Appendix M

Science Teachers' Mean Scores and Frequencies by Item for the Attitude Toward Teaching at Higher Levels of Cognition Questionnaire

Table J1

Means and Frequencies by Item for Attitude Toward Teaching at Higher Cognitive Levels as Reported by Science Teachers (n=9)

			Responses											
			Strongly Disagree		Moderately Disagree		Slightly Disagree		Slightly Agree		Moderately Agree		Strongly Agree	
Item	*X*	*SD*	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Students will develop more life-long learning skills if they are taught to create.	5.78	0.44	0	0.00	0	0.00	0	0.00	0	0.00	2	22.22	7	77.78
I enjoy opportunities for increasing the cognitive level of my teaching.	5.67	0.71	0	0.00	0	0.00	0	0.00	1	11.11	1	11.11	7	77.78
I want to teach toward higher cognitive levels.	5.67	0.71	0	0.00	0	0.00	0	0.00	1	11.11	1	11.11	7	77.78
Students will develop more life-long learning skills if they are taught to evaluate.	5.67	0.50	0	0.00	0	0.00	0	0.00	0	0.00	3	33.33	6	66.67
Higher level teaching is critical to the permanent learning of students.[a]	5.63	0.52	0	0.00	0	0.00	0	0.00	0	0.00	3	37.50	5	62.50
It is important for teachers to assist students in developing higher level thinking skills.	5.59	0.33	0	0.00	0	0.00	0	0.00	0	0.00	1	11.11	8	88.89
It is important for students to be able to process information.	5.56	0.53	0	0.00	0	0.00	0	0.00	0	0.00	4	44.44	5	55.56
Teachers' teaching objectives should be written to challenge students at higher cognitive levels.	5.44	0.88	0	0.00	0	0.00	0	0.00	2	22.22	1	11.11	6	66.67
Skills in evaluating will prove to be valuable to students.	5.44	0.73	0	0.00	0	0.00	0	0.00	1	11.11	3	33.33	5	55.56
Students in my course deserve to be challenged at higher cognitive levels.	5.44	0.73	0	0.00	0	0.00	0	0.00	1	11.11	3	33.33	5	55.56

Continued on next page

Table J1 continued

			Responses											
			Strongly Disagree		Moderately Disagree		Slightly Disagree		Slightly Agree		Moderately Agree		Strongly Agree	
Item	*X*	*SD*	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Teachers need to encourage students to practice higher level thinking.	5.33	1.66	1	11.11	0	0.00	0	0.00	0	0.00	1	11.11	7	77.78
I am willing to spend more time on certain topics to teach them at higher cognitive levels.	5.33	0.87	0	0.00	0	0.00	0	0.00	2	22.22	2	22.22	5	55.56
I try to teach students to process the information that I present.	5.33	0.50	0	0.00	0	0.00	0	0.00	0	0.00	6	66.67	3	33.33
As I teach at higher cognitive levels, I expect to see students thinking at higher cognitive levels.	5.33	0.50	0	0.00	0	0.00	0	0.00	0	0.00	6	66.67	3	33.33
I want to teach in a way that allows students to see higher levels of thinking exhibited.	5.22	1.64	1	11.11	0	0.00	0	0.00	0	0.00	2	22.22		66.67
I am willing to devote more time to grade assignments designed to assess at higher cognitive levels.	5.22	1.20	0	0.00	0	0.00	1	11.11	2	22.22	0	0.00	6	66.67
Students are willing to do more than memorize.	5.22	0.83	0	0.00	0	0.00	0	0.00	2	22.22	3	33.33	4	44.44
Students should be given more opportunities to exercise creativity.	5.22	0.83	0	0.00	0	0.00	0	0.00	2	22.22	3	33.33	4	44.44
Getting students to evaluate is an important goal of higher cognitive level teaching.	5.22	0.83	0	0.00	0	0.00	0	0.00	2	22.22	3	33.33	4	44.44
I try to teach students to analyze.	5.22	0.67	0	0.00	0	0.00	0	0.00	1	11.11	5	55.56	3	33.33

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Table J1 continued

Item	X	SD	Responses: Strongly Disagree f	%	Moderately Disagree f	%	Slightly Disagree f	%	Slightly Agree f	%	Moderately Agree f	%	Strongly Agree f	%
I would like to know more about teaching at higher cognitive levels.	5.11	1.69	1	11.11	0	0.00	0	0.00	1	11.11	1	11.11	6	66.67
Teachers need to assist students in transferring material to different contexts.	5.11	0.78	0	0.00	0	0.00	0	0.00	2	22.22	4	44.44	3	33.33
I try to teach students to develop new ideas, products, or processes.	5.11	1.05	0	0.00	0	0.00	1	11.11	1	11.11	3	33.33	4	44.44
The higher the academic level of the course, the higher the cognitive level at which the course should be taught.	5.11	1.05	0	0.00	0	0.00	1	11.11	1	11.11	3	33.33	4	44.44
I have to be patient to nurture higher level thinking among students.	5.11	0.78	0	0.00	0	0.00	0	0.00	2	22.22	4	44.44	3	33.33
I teach students to separate fact from opinion.	5.00	0.87	0	0.00	0	0.00	0	0.00	3	33.33	3	33.33	3	33.33
Any subject matter can be taught at higher cognitive levels.	4.89	1.27	0	0.00	1	11.11	0	0.00	1	1.10	4	4.44	3	33.33
The quality of students at the undergraduate level allows for higher cognitive level teaching.	4.33	1.00	2	22.22	0	0.00	0	0.00	3	33.33	3	33.33	1	11.11
Teachers encourage too much memorization.	4.33	0.87	0	0.00	2	22.22	2	22.22	5	55.56	0	0.00	1	11.11
Students will operate at the cognitive level at which I expect them to operate.	4.11	2.03	2	22.22	0	0.00	1	11.11	1	11.11	2	22.22	3	33.33

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Table J1 continued

Item	X	SD	Responses											
			Strongly Disagree		Moderately Disagree		Slightly Disagree		Slightly Agree		Moderately Agree		Strongly Agree	
			f	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Students complain too much when they are taught at higher levels of cognition.	4.11	0.78	0	0.00	0	0.00	2	22.22	4	44.44	3	33.33	0	0.00
I intend to substantially revise my current cognitive level of teaching.	4.00	1.50	0	0.00	2	22.22	1	11.11	3	33.33	1	11.11	2	22.22
It is the responsibility of the students to take information from class and use it at higher cognitive levels.	4.00	1.50	1	11.11	1	11.11	0	0.00	2	22.22	5	55.56	0	0.00
I receive recognition by my co-workers for accomplishing higher cognitive level teaching.	4.00	1.00	0	0.00	1	11.11	1	11.11	4	44.44	3	33.33	0	0.00
Teachers do not have the extra time needed to teach across different levels of cognition.	3.89	2.09	2	22.22	1	11.11	0	0.00	2	22.22	1	11.11	3	33.33
The cognitive level(s) at which I teach is adequate.[a]	3.50	1.31	0	0.00	2	25.00	3	37.50	0	0.00	3	37.50	0	0.00
I would need assistance in order to teach at higher levels of cognition.[a]	3.38	1.60	1	12.50	2	25.00	1	12.50	1	12.50	3	37.50	0	0.00
Teachers present too much material at the evaluating level of cognition.[a]	3.13	1.46	1	12.50	1	12.50	4	50.00	1	12.50	0	0.00	1	12.50
Students, in my courses, generally are not mentally ready to be challenged at higher cognitive levels.	3.00	0.87	0	0.00	3	33.33	3	33.33	3	33.33	0	0.00	0	0.00
I am frustrated about teaching at higher cognitive levels.	2.78	1.39	3	33.33	0	0.00	2	22.22	4	44.44	0	0.00	0	0.00

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Table J1 continued

			Responses											
			Strongly Disagree		Moderately Disagree		Slightly Disagree		Slightly Agree		Moderately Agree		Strongly Agree	
Item	*X*	*SD*	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
I could teach at higher levels of cognition, but choose not to.	2.67	1.50	3	33.33	1	11.11	2	22.22	2	22.22	1	11.11	0	0.00
Large classes do not lend themselves to methods which reflect teaching toward higher cognitive levels.	2.56	1.24	1	11.11	5	55.56	1	11.11	1	11.11	1	11.11	0	0.00
The nature of lower level classes does not require higher cognitive level teaching.	2.44	1.51	2	22.22	4	44.44	2	22.22	0	0.00	0	0.00	1	11.11
Teaching at the higher cognitive levels requires too much advanced preparation.	2.33	1.73	4	44.44	2	22.22	1	11.11	1	11.11	0	0.00	1	11.11
Modeling higher level thinking in class will not influence students to think at higher levels.	2.11	1.62	4	44.44	3	33.33	1	11.11	1	11.11	0	0.00	0	0.00
My subject matter does not lend itself to higher cognitive level teaching.	1.89	1.62	5	55.56	3	33.33	0	0.00	0	0.00	0	0.00	1	11.11
Freshman level students cannot be taught at higher levels of cognition.	1.67	1.32	6	66.67	2	22.22	0	0.00	0	0.00	1	11.11	0	0.00
Application activities are a low priority when I plan.	1.67	1.00	5	55.56	3	33.33	0	0.00	1	11.11	0	0.00	0	0.00
It takes more time than it is worth to increase the cognitive level of my teaching.	1.22	0.44	7	77.78	2	22.22	0	0.00	0	0.00	0	0.00	0	0.00
Students can get the knowledge they need from high school by memorizing.	1.22	0.67	8	88.89	0	0.00	1	11.11	0	0.00	0	0.00	0	0.00

Note. [a] n = 8

Appendix N

Classroom Observation Results: Florida

Taxonomy of Cognitive Behavior

Table L1
Instructor 1-A

Observation	Cognitive level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	11.76	4.55	0.46
	Comprehension	52.94	20.45	4.09
	Application	23.53	9.09	2.73
	Evaluation	11.76	4.55	2.28
2	Knowledge	100.00	18.18	1.82
3	Knowledge	57.89	25.00	2.50
	Comprehension	42.11	18.18	3.64
Total			100.00	17.52

Table L2
Instructor 1-B

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	69.44	21.55	2.16
	Comprehension	30.56	9.48	1.90
2	Knowledge	66.67	20.69	2.07
	Comprehension	25.00	7.76	1.55
	Application	5.56	1.72	0.52
	Analysis	2.78	0.86	0.34
3	Knowledge	29.09	22.42	2.24
	Comprehension	40.91	15.52	3.10
Total			100.00	13.88

Table L3
Instructor 2-A

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	47.06	15.53	1.55
	Comprehension	35.29	11.65	2.33
	Application	8.82	2.91	0.87
	Analysis	5.88	1.94	0.78
	Synthesis	2.94	0.97	0.49
2	Knowledge	42.11	15.54	1.55
	Comprehension	50.00	18.45	3.69
	Application	2.63	0.97	0.29
	Analysis	5.26	1.94	0.78
3	Knowledge	48.39	14.56	1.46
	Comprehension	48.39	14.57	2.91
	Application	3.23	0.97	0.29
Total			100.00	16.99

Table L4
Instructor 2-B

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	50.00	17.81	1.78
	Comprehension	26.92	9.59	1.92
	Analysis	23.08	8.22	3.29
2	Knowledge	36.00	12.33	1.23
	Application	32.00	10.96	3.29
	Analysis	32.00	10.95	4.38
3	Knowledge	65.55	16.44	1.64
	Comprehension	31.82	9.59	1.92
	Analysis	13.64	4.11	1.64
Total			100.00	21.09

Table L5
Instructor 3-A

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	46.15	17.14	1.71
	Comprehension	38.46	14.29	2.86
	Application	11.54	4.29	1.29
	Analysis	3.85	1.43	0.57
2	Knowledge	65.00	18.57	1.86
	Comprehension	25.00	7.14	1.43
	Application	10.00	2.86	0.86
3	Knowledge	33.33	11.43	1.14
	Application	33.33	11.42	3.43
	Analysis	33.33	11.43	4.57
Total			100.00	19.72

Table L6
Instructor 3-B

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	37.93	11.96	1.20
	Comprehension	44.83	14.13	2.83
	Application	13.76	4.35	1.31
	Analysis	3.45	1.09	0.44
2	Knowledge	79.41	29.35	2.94
	Comprehension	17.65	6.52	1.30
	Application	2.94	1.08	0.32
3	Knowledge	89.66	28.26	2.83
	Comprehension	10.34	3.26	0.65
Total			100.00	13.82

Table L7
Instructor 4-A

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	74.07	25.64	2.56
	Comprehension	18.52	6.41	1.28
	Application	7.47	2.56	0.77
2	Knowledge	52.00	16.67	1.67
	Comprehension	32.00	10.26	2.05
	Application	4.00	1.28	0.38
	Analysis	12.00	3.85	1.54
3	Knowledge	19.23	6.41	0.64
	Comprehension	38.46	12.82	2.56
	Application	19.23	6.41	1.92
	Analysis	23.08	7.69	3.08
Total			100.00	18.45

Table L8
Instructor 4-B

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	27.27	7.42	0.74
	Comprehension	59.09	16.05	3.21
	Application	9.09	2.47	0.74
	Synthesis	4.55	1.24	0.62
2	Knowledge	93.55	35.80	3.58
	Comprehension	3.23	1.23	0.25
	Analysis	3.23	1.23	0.50
3	Knowledge	50.00	17.28	1.73
	Comprehension	17.86	6.17	1.23
	Analysis	10.71	3.70	1.48
	Synthesis	21.43	7.41	3.71
Total			100.00	17.79

Table L9

Instructor 5-A

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	50.00	18.03	1.80
	Comprehension	45.45	16.39	3.28
	Analysis	4.55	1.64	0.66
2	Knowledge	48.28	22.95	2.30
	Comprehension	44.83	21.31	4.26
	Application	6.90	3.28	0.98
3	Knowledge	20.00	3.28	0.33
	Application	70.00	11.48	3.44
	Analysis	10.00	1.64	0.66
Total			100.00	17.71

Table L10

Instructor 5-B

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	53.57	19.48	1.95
	Comprehension	35.71	12.99	2.60
	Analysis	10.71	3.90	1.56
2	Knowledge	66.67	25.97	2.60
	Comprehension	30.00	11.69	2.34
	Application	33.33	1.30	0.39
3	Knowledge	68.42	16.88	1.69
	Comprehension	31.58	7.79	1.56
Total			100.00	14.69

Table L11

Instructor 6-A

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	70.00	23.33	2.33
	Comprehension	30.00	10.00	2.00
2	Knowledge	81.82	30.00	3.00
	Comprehension	18.18	6.67	1.33
3	Knowledge	22.22	6.67	0.67
	Comprehension	22.22	6.67	1.33
	Application	44.44	13.33	4.00
	Analysis	11.11	3.33	1.33
Total			100.00	15.99

Table L12

Instructor 6-B

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	46.67	17.28	1.73
	Comprehension	36.67	13.58	2.72
	Application	16.67	6.18	1.85
2	Knowledge	50.00	14.81	1.48
	Comprehension	45.83	13.58	2.72
	Analysis	4.17	1.24	0.50
3	Knowledge	62.96	20.99	2.10
	Comprehension	25.93	8.64	1.73
	Analysis	11.11	3.70	1.48
Total			100.00	16.31

Table L13

Instructor 7-A

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	42.86	14.29	1.43
	Comprehension	14.29	4.76	0.95
	Application	23.81	7.94	2.38
	Evaluation	19.05	6.35	3.18
2	Knowledge	66.67	25.40	2.54
	Comprehension	33.33	12.70	2.54
3	Knowledge	22.22	6.34	0.63
	Comprehension	33.33	9.52	1.90
	Application	44.44	12.70	3.81
Total			100.00	19.36

Table L14

Instructor 7-B

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	66.67	21.62	2.16
	Comprehension	12.50	4.05	0.81
	Application	20.83	6.76	2.03
2	Knowledge	48.48	21.63	2.16
	Comprehension	30.30	13.51	2.70
	Analysis	21.21	9.46	3.78
3	Knowledge	47.06	10.81	1.08
	Comprehension	52.94	12.16	2.43
Total			100.00	17.15

Table L15

Instructor 8-A

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	46.43	21.31	2.13
	Comprehension	39.29	18.03	3.61
	Analysis	14.29	6.56	2.62
2	Knowledge	64.29	14.75	1.48
	Comprehension	28.57	6.56	1.31
	Analysis	7.14	1.64	0.66
3	Knowledge	42.11	13.11	1.31
	Comprehension	42.11	13.12	2.62
	Application	5.26	1.64	0.49
	Analysis	10.53	3.28	1.31
Total			100.00	17.54

Table L16

Instructor 8-B

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	53.66	25.88	2.59
	Comprehension	36.59	17.65	3.53
	Application	2.44	1.18	0.35
	Analysis	7.32	3.53	1.41
2	Knowledge	51.85	16.47	1.65
	Comprehension	22.22	7.06	1.41
	Application	18.52	5.88	1.76
	Analysis	7.41	2.35	0.94
3	Knowledge	47.06	9.41	0.94
	Comprehension	5.88	1.18	0.24
	Application	47.06	9.41	2.82
Total			100.00	17.64

Table L17

Instructor 9-A

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	91.67	21.58	2.16
	Comprehension	8.33	1.96	0.34
2	Knowledge	82.35	54.90	5.49
	Comprehension	8.82	5.88	1.18
	Analysis	8.82	5.88	2.35
3	Knowledge	100.00	9.80	0.98
Total			100.00	12.50

Table L18

Instructor 9-B

Observation	Cognitive Level	Percentage of Observation	Percentage of Total Behavior	Total Cognitive Weight
1	Knowledge	64.29	25.71	2.57
	Comprehension	25.00	10.00	2.00
	Application	7.14	2.86	0.86
	Analysis	3.57	1.43	0.57
2	Knowledge	18.75	4.29	0.43
	Application	37.50	8.57	2.57
	Analysis	43.75	10.00	4.00
3	Knowledge	65.38	24.28	2.43
	Comprehension	26.92	10.00	2.00
	Analysis	3.85	1.43	0.57
	Evaluation	3.85	1.43	0.72
Total			100.00	18.72

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