# TESTING THE EFFECT OF A SCIENCE-ENHANCED CURRICULUM ON THE SCIENCE ACHIEVEMENT AND AGRICULTURAL COMPETENCY OF SECONDARY AGRICULTURAL EDUCATION STUDENTS

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"When you are willing to make sacrifices for a great cause, you will never be alone."

Coretta Scott King

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# CHAPTER I

# INTRODUCTION

A majority of America's high school students are not adequately prepared for the workforce or post-secondary education (Wilmer, 2008). Research suggests that expectations of higher education and preparation of secondary students is not aligned and, thus, is creating a potential block toward student success in post-secondary education (Breneman, Ewell, McCluskey, Reindl, & Volkwein, 2004). This potential block or barrier toward post secondary educational access is evident where enrollment in developmental coursework designed to enhance student performance up to institutional standards is at 41% for freshman students enrolled in two-year colleges and 22% enrollment in four-year institutions (Stephens, 2001). Wilmer (2008) opined that, ". . . when students need developmental coursework in reading, basic arithmetic or a combination of subjects, their risk factor of not achieving their academic goals significantly increases" (p. 6). This leads to concern at the secondary education level.

With a need for increased accountability of the Nation's students regarding their educational performance, in 2001, a seminal piece of legislation known as "No Child Left

Behind" (NCLB) was created and passed by Congress and signed into law by President Bush in January 2002 (Apple, 2006). With passage of this legislation, the responsibility of local school districts increased (Ricketts, Duncan, & Peake, 2006) to meet the educational needs of secondary students. Specifically, accountability was emphasized in core curriculums such as mathematics, science, and English. This greater than before accountability has led to a focus on testing requirements (Ricketts et al., 2006). As an answer to the challenge of increased accountability, Ricketts et al. stated that teachers were escalating, by a considerable amount, their efforts at ensuring that students learn to "pass the test" (e.g., "High stakes tests") as a result of NCLB.

The academic skills of today's teenagers are diminishing and cause for concern among both state and national officials exists (Cavanagh, 2004). Provasnik, Gonzales, and Miller (2009) compared the average science scale scores of students in the United States to international students in the areas of reading, mathematics, and science. It was determined that Oklahoma ranked 28th in the nation out of the 45 states who reported science achievement scores. This figure is discouraging and serves as an indicator of the lack of preparedness of students for higher education and the real world.

Cavanagh (2004) noted that, according to American College Testing (ACT) program, 78% of students who took a college entrance examination were deficient in the areas of mathematics, science, and English. Thus, it was determined that these students were ill-prepared for college-level coursework, justifying the need for improvements at the secondary level. Further, it was noted in the latest Program for International Student Assessment (PISA) that, "U.S. 15-year-olds are not able to apply scientific knowledge and skills to real world tasks as well as their peers . . ." (Provasnik et al., 2009, p. 45).

Science instruction and student success is a hot topic in the educational world (Dickinson & Jackson, 2008; National Center for Education Statistics, 2005; Provasnik et al., 2009). It was identified by the National Commission on Excellence in Education that a ". . . widespread public perception that something is seriously remiss in our educational system" (NCEE, 1983, p. 1) exists. Additionally, in the report, *A Nation at Risk: The Imperative for Educational Reform*, it was stated that, ". . . The educational foundations of our society are being eroded by a rising tide of mediocrity" (p. 5). Loyd (1992) posited that as a result of three decades of educational reports, evidence exists to support the need for educational change. Reports on the success of students from across the globe in comparison to the achievements of those in the United States indicate that American students are falling behind in science achievement when compared to other countries (National Center for Education Statistics, 2005; Provasnik et al., 2009). Further, it appears as though progress in science achievement of American students has been stagnating. As of 2007, the United States was ranked ninth out of 47 countries participating in the TIMSS. Countries out-ranking American students in science achievement scores were Singapore, Chinese Taipei, Japan, Korea, England, Hungary, the Czech Republic, Slovenia, and the Russian Federation (National Center for Education Statistics, 2005).

Secondary agricultural education exists to prepare people for college and careers (Roberts & Ball, 2009). Because it has long been lauded as the world's oldest science (Ricketts et al., 2006), agricultural education strives to help students understand scientific principles and concepts in the context of agriculture better (Thompson & Balschweid, 2000). As such, agricultural education could serve as an effective medium or "content" to convey scientific terminology, principles, and those concepts that are inherent to botany and zoology.

This is essential during a time when increased graduation requirements and other constraints mandated by NCLB effectively eliminates the majority of options for students who desire to take elective coursework during their high school experience (Luft, 2004).

One such curriculum designed to convey scientific principles in the context of agriculture is available through the Center for Agricultural and Environmental Research and Training (CAERT). CAERT provides agriculturally-based, science-enhanced materials available for use in agricultural and environmental instructional areas at the secondary level. Specializing in activities that are collaborative by nature, students of agricultural education are provided a curriculum that is intended to allow them to be more actively involved and engaged in the learning process (CAERT, 2010a).

## Statement of the Problem

High stakes tests have placed increased requirements on schools to raise students' test scores in science. Moreover, the ever-increasing demand for workers who are scientifically literate and capable of applying their understanding of science in the workplace continues to be an escalating imperative. Agricultural education, at the secondary level, including animal science and horticulture curriculums, is inherently based on fundamental science principles and concepts. However, little empirical evidence exists that demonstrates whether teaching a science-enhanced curriculum in the context of animal or plant science courses would affect student achievement in science positively. Further, little is known as to how teaching a science-enhanced curriculum would affect students' agricultural content knowledge, generally. Accordingly, the need for scholarly inquiry is warranted.

## Purpose

The purpose of this study was to determine if a science-enhanced curriculum (i.e., CAERT) taught in a secondary level animal science or horticulture course would significantly improve students' understanding of selected scientific principles, when compared to students who were instructed using a traditional curriculum. A secondary purpose was to determine the effect that the science-enhanced CAERT curriculum would have on students' agricultural knowledge when compared to students who were instructed using a traditional curriculum. The following research questions guided this study.

## Research Questions

1. What were the personal characteristics (i.e., gender, age, grade classification, Biology I End of Instruction score, race/ethnicity and number of agricultural education courses taken) of students enrolled in selected animal science or horticulture courses in Oklahoma during spring semester 2010?
2. What were the personal characteristics (i.e., age, gender, race/ethnicity, years of teaching experience, certification areas and highest degree held) of instructors who taught selected animal science or horticulture courses in Oklahoma during the spring semester 2010?
3. What was the effect of a science-enhanced curriculum (produced by the Center for Agricultural and Environmental Research and Training [CAERT]) on students' science achievement, as determined by a science proficiency examination?
4. What effect did the science-enhanced CAERT curriculum, designed for animal science or horticulture courses, have on students' agricultural technical skill

competence, as determined by state competency examinations for animal science and horticulture?

5. What were selected perceptions of instructors who used the science-enhanced CAERT curriculum to teach selected animal science or horticulture courses during spring semester 2010?

## Null Hypotheses

$H_o1$: The science achievement of students who received the science-enhanced CAERT curriculum in animal science or horticulture will not differ significantly (i.e., $p < .05$) from those students who were taught the traditional animal science or horticulture curriculum, as measured by the TerraNova[3] science achievement examination ($H_o$: $\mu_{1\text{treatment group}} = \mu_{2\text{comparison group}}$).

$H_o2$: The agricultural technical competence of students who received the science-enhanced CAERT curriculum in animal science or horticulture will not differ significantly (i.e., $p < .05$) from those students who received a traditional animal science or horticulture curriculum, as measured by a technical competency test in animal science or horticulture ($H_o$: $\mu_{1\text{ treatment group}} = \mu_{2\text{ comparison group}}$).

## Assumptions

The following assumptions were made pertaining to this study:

1. Students involved in the study performed to the best of their ability on all measures of achievement.
2. Teachers involved in the study (both comparison and treatment) did not discuss or

share curriculum materials while the study was in progress.

3. Comparison group teachers taught the animal science or horticulture curriculums as they had in the past using non-CAERT curriculum materials.
4. Treatment group teachers taught their animal science or horticulture courses using the CAERT curriculum as provided.
5. Both comparison group and treatment group teachers provided accurate data as requested by weekly, web-based fidelity reports.
6. Students' EOI scores would be accessible to the researcher.

## Delimitations of the Study

The delimitations of this study include a purposeful sample treatment and comparison group consisting of secondary science-credentialed agricultural educators in the state of Oklahoma who were teaching animal science or horticulture courses during the 2009-2010 school year. Additionally, this study included the students who were enrolled in those courses during that time.

## Limitations of the Study

The following limitations guided the study:

1. It is possible that some non-treatment related variability in instruction between the treatment and comparison groups existed as to bias the findings of the study.
2. The treatment group was pre-selected from a pool of science-credentialed teachers by the Oklahoma Department of Career and Technology Education (ODCTE), Agricultural Education Division. Because no random sample selection occurred, a

level of bias may have existed.

3. The comparison group was purposeful in nature and selected from a pool of science-credentialed teachers by the researcher according to information obtained from the state's Computerized Enrollment System for Instructors (CESI) report. Because random sampling was not utilized, findings from the study should not be generalized beyond the scope of this study's population.
4. The study's design called for a semester-long intervention of the treatment (i.e., the science-enhanced, CAERT curriculum). As a result of the short duration of the intervention, results may differ significantly from a year-long intervention.

## Operational Definitions

Agricultural Education – Also referred to as Agriscience and older terminology such as Vocational Agriculture, Oklahoma offers this curriculum in approximately 353 high schools preparing students for occupations in production agriculture, agribusiness, and other emerging occupations in agricultural education (ODCTE, 2010a).

Agricultural Education Teacher – A teacher of "a program of instruction in and about agriculture and related subjects commonly offered in secondary schools, through some elementary and middle schools and some postsecondary institutes/community colleges also offer such instruction" (Talbert, Vaughn, Croom, & Lee, 2007, p. 509).

Agricultural Power and Technology – Curriculum designed to provide information relating to the safety, maintenance, selection and operation of agricultural production equipment and associated activities in the areas of agricultural power, electricity, structures and utilities as well as welding and cutting (ODCTE, 2010b)

Agriculture, Food and Natural Resources career cluster areas – A curriculum structure to include "production, processing, marketing, distribution, financing, and development of agricultural commodities and resources including food, fiber, wood products, natural resources, horticulture, and other plant and animal products/resources" (Oklahoma Department of Career and Technology Education, 2010f, para. 1).

American College Testing Program (ACT) – Test designed to assess student competency in academic areas in their educational development to determine their ability to complete college-level work (ACT, 2010).

Animal Science Curriculum – An instructional curriculum designed to identify the needs of animals relating to nutritional, reproduction, biotechnology, health, and the different environmental requirements of livestock production (CAERT, 2010b).

Career and Technical Education (CTE)–A term used to describe vocational and career based instruction in Oklahoma. *

Carl D. Perkins Vocational and Technical Education Act – Federal legislation that provides for state funding in the academic, vocational, and technical area.  This act promotes the integration of academics with instruction in the career and technology areas and establishes the expenditures allowable in Career and Technology Education (ODCTE, 2010c).

Center for Agricultural and Environmental Research and Training (CAERT) – A commercial curriculum design company dedicated to the development of science-based instruction in agricultural and environmental education (CAERT, 2010a).

Computerized Enrollment System for Instructors (CESI) report – A report designed to provide enrollment data in Career and Technology Education to the ODCTE and to collect data relating to funding, historical trends, economic development, decision making, evaluation standards and student placement (ODCTE, 2010d).

Curriculum – “The list of all courses offered in a school; also a group of related courses, such as the agricultural education curriculum” (Talbert, Vaughn, Croom, & Lee, 2007, p. 512).

Curriculum of Agricultural Sciences Education (CASE) model – A national curriculum designed to provide educational experiences and to increase the rigor and relevance of agricultural curriculum (Team AGED, 2007).

Digital Immigrant – Term used to describe those individuals, who were not born in the technological era, but have had to adopt and embrace the use of new technology (Prensky, 2001a).

Digital Natives – Term used to describe those students of today who are “native speakers” in the technology areas of computers, video games, and Internet technology (Prensky, 2001a).

E-Unit – E-Units are online student text materials that are designed to reinforce the lesson plans associated with the science-enhanced, CAERT curriculum (D. Pentony, personal communication, December 6, 2010).

Fidelity Report – A report designed to identify a level of intended delivery of a treatment condition in research (Moncher & Prinz, 1991).

Georgia High School Graduation Test (GHSGT) – A graduation test utilized in Georgia covering four content areas and a Georgia High School writing assessment test. Used to determine if a student has met the requirements for graduation in the state (Georgia Department of Education, 2010).

High Stakes Tests – High-stakes tests are used to make significant educational decisions about schools, teachers, administrators, and students (Amrein & Berliner, 2002, p. 1).

Horticulture Curriculum – A curriculum designed for the instruction of all major areas of horticulture to include competencies in plant science, landscaping, nursery production, as well as floriculture (CAERT, 2010b).

National Research Center for Career and Technical Education (NRCCTE) – The NRCCTE is an agency currently located at the University of Louisville responsible for the dissemination of scientific knowledge with regard to career and technical education in the United States (NRCCTE, 2010).

No Child Left Behind (NCLB) Act – An amendment to the Elementary and Secondary Education Act of 1965; a bipartisan educational reform act proposed by President George W. Bush and signed into law by Congress on January 8, 2002 (U.S. Department of Education, 2010).

Oklahoma Department of Education's End of Instruction (EOI) examination in science – A secondary level test in the area of science that has been aligned to the Oklahoma Department of Education's curriculum standards (Oklahoma State Department of Education, 2010a).

Priority Academic Student Skills (PASS) – A set of curriculum standards adopted by the Oklahoma State Board of Education designed to identify the needed academic skills of students at all public schools in the state (Oklahoma State Department of Education, 2010a).

Program for International Student Assessment (PISA) – A learning assessment regimen sponsored by the Organization for Economic Cooperation and Development (OECD) that assesses the literacy of 15-year-old students in the areas of reading, mathematics, and science (Provasnik et al., 2009).

Science Credentialed Teachers – A certified teacher who holds at least a bachelor's degree with the appropriate license/certificate to instruct science (OSDE, 2010d).

Science, Technology, Engineering, and Mathematics (STEM) – Subject areas identified as being necessary for a student to become proficient in to obtain a above standard wage paying career in relation to the 21st century economy (Morrison & Bartlett, 2009).

Trends in International Mathematics and Science Study (TIMSS) – A program sponsored by the International Association for the Evaluation of Educational Achievement (IEA) that assesses the performance of students in the 4th and 8th grades in the areas of mathematics and science (Provasnik et al., 2009).

**Note.* Definitions followed by this identifier were developed by the researcher and are potentially unique to this research study.

# CHAPTER II

# REVIEW OF LITERATURE

## Introduction

The purpose of this chapter is to form a coherent sequence of topics that leads to a theoretical framework that supports the main idea of the study. Themes that have been developed to support the framework of the research and lead to a logical theoretical framework design have been developed and include the following: (1) Introduction; (2) Learning in and about Agriculture; (3) Student Science Learning and Achievement; (4) Curriculum Integration to Improve Student Learning and Achievement; (5) Socio Economic Status and Student Academic Achievement; (6) Conceptual/Theoretical Framework and (7) Summary.

## Learning in and about Agriculture

### *Purpose of Secondary Agricultural Education*

Vocational agriculture education arose out of the need for skilled laborers at a time when rapid industrialization changed the culture of America (Dewey, 1977; Roberts & Ball, 2009) and training was necessary to educate students for their future role in industry. Two "schools of thought" during this time of industrialization, perceived the purpose of vocational education in different ways. David Snedden, who was considered to be a social efficiency proponent (Drost, 1977) espoused that vocational education was designed to prepare students for a specific vocational occupation. Conversely, John Dewey supported the position that an education "would expand a person's horizons and provide him with the tools to interpret and to alter his world" (Drost, 1977, p. 20). It was Dewey's opinion that students should be educated in a holistic manner where academic subjects and skills necessary for success in vocational areas were combined and blended to help the student develop "transferable life skills" (Roberts & Ball, 2009). Roberts and Ball identified that the general opinion of the nation at the time was to prepare students for skilled labor, aligning with the opinion of Snedden, who was instrumental in the passage of the Smith-Hughes Act – a catalyst for the teaching of vocational agriculture in the United States.

Today, agricultural education's primary purpose is that of preparing individuals for agricultural careers and advancement in related professions (Phipps, Osborne, Dyer, & Ball, 2008; Roberts & Ball, 2009). Even though some would say that agricultural education has changed drastically since its humble beginnings (Phipps et al., 2008), the general idea fomenting the program remains the same – "Developing knowledge and skill in agriculture and natural resources to support the industry, occupational needs, and personal interests of students" (Phipps et al., 2008, p. 3).

*Industry Needs Related to Animal and Plant Science, Including Horticulture*

It has been projected that within the next 20 years a deficit of workers in the United States will occur, requiring 20 million laborers and skilled workers to fill positions vacated by the retirement of the "baby-boomer" generation (Carnevale &

Desrochers, 2003; Eldredge & Johnson, 2008). With the increased need for skilled workers, the report, A Nation at Risk: The Imperative for Educational Reform identified that, curricular materials in the public school systems will need to be updated to reflect the needs of the fine arts as well as career and technical education (National Commission on Excellence in Education, 1983).

According to Phipps and Osborne (1988), the purpose of agricultural education from a content-centered point of view “is to develop the knowledge and skills required for successful employment in the agricultural industry” (Roberts & Ball, 2009, p. 82). The shortage of skilled workers positioned to replace the retiring “baby boomer” generation is deficient and is considered to be an increasing dilemma in our nation (Slusher, Robinson, & Edwards, 2010). To that end, it is increasingly important that agricultural educators continue preparing students for the workforce in the secondary setting (Lynch, 2000).

At one time, the United States was considered to be secure in its position as a world leader in the international marketplace (National Commission on Excellence in Education, 1983). This is no longer the case; Educational reform, aligning with industry standards, must be considered.

Myers and Dyer (2006) stated that, “The scientific literacy needs of individuals entering careers in agriculture are becoming increasingly important” (p. 52). Moreover, it is essential that preparation for the job market include skills that develop students’ abilities to reason, make decisions, and solve problems (Myers & Dyer). Experiential learning activities where students can develop agriculturally-oriented skills are capable of reinforcing those scientific processes (Mabie & Baker, 1996) and are transferable across multiple contextual areas such as animal and plant science.

The instruction of life science at an advanced level through an animal science context has been shown to increase the marketability of students in the workplace as well as serving as a spring board for educational success after secondary education (Balschweid & Huerta, 2008). Moreover, the instruction of animal agriculture with an emphasis on scientific principles is indicative of an effective method in increasing student appreciation and understanding of basic science more effectively than conventional biology instruction (Balschweid, 2002). Balschweid and Huerta (2008) found that secondary students in agricultural education who were enrolled in an advanced life science curriculum taught in the context of animal agriculture learned the transferable skills (i.e., ability to function in experimental settings, the conduction of laboratory write-ups, team work, and problem solving) needed for achievement in scientific commerce and industry.

*Career Pathways in Animal and Plant Science, Including Horticulture*

A drastic change in the vision and intended purpose of career and technical education has occurred (CTE) (Ruffing, 2006) recently. CTE has experienced changes in the priorities of the workplace that were initiated originally through the adoption of the Smith-Hughes Act in 1917 (Ruffing). However, CTE is no longer viewed as simply a "feeder" curriculum for employment in industry. An era of rather highly skilled workers positioned to replace the declining labor force of a past manufacturing economy is on the horizon, especially in the information-based industries (Wilmer, 2008).

Change to a more technologically driven workplace has necessitated the need for trained workers who are acclimatized to the needs of a global society and an economy positioned for transitional change (Friedman, 2005). The Smith-Hughes Act, along with multiple reauthorizations of the Carl D. Perkins Vocational and Technical Education Act, have been responsible for educational reform historically. More recent, the latter has amplified the call for increased rigor and career opportunities in CTE in relation to industry needs (Ruffing, 2006) and academic expectations.

Agricultural education has responded to this need and has been viewed as responsive to the change that is needed regarding the educational requirements of its students (Roberts & Ball, 2009). As a result, the National Association of State Directors for Career and Technical Education (NASDCTE) has been instrumental in developing guidelines essential to the expansion of the needs of agricultural education students, as well as other career cluster areas (Ruffing, 2006). The vision of NASDCTE has identified several principles crucial to meeting the needs of industry (Ruffing). Among these include maintaining a high level of excellence in academics and industry values, a measure of accountability of the performance of CTE participants, and rigorous expectations for student success in the program.

In regard to the drastic change in the vision and intended purpose of career and technical education espoused by Ruffing (2006), the Oklahoma Department of Career and Technology Education (ODCTE) developed an official framework outlining the career clusters for Agriculture, Food, and Natural Resources (ODCTE, 2010f). There are seven career major pathways being used currently which include food products and processing; plant and soil science; animal science; agricultural power, structures, and technology;

agribusiness and management; agricultural communications; and natural resources and environmental science (ODCTE, 2010f). The different agricultural career pathways in Oklahoma emphasize information that is necessary for career success in the state in, "the production, processing, marketing, distribution, financing, and development of agricultural commodities and resources including food, fiber, wood products, natural resources, horticulture, and other plant and animal products/resources" (ODCTE, 2010f, para. 1). Because agriculture is the world's oldest science (Ricketts et al., 2006), it is natural that career cluster areas such as plant and soil science and animal science be heavily vetted with regard to botany and zoology principles.

*Curricular Integration in Agricultural Education*

Incorporating these principles espoused by NASDCTE in agricultural education courses reinforces the work of Dewey (1938). Dewey argued for the integration of academics and vocational training designed especially to reinforce the principles of learning. Moreover, he identified that the development of life skills readily transferable across contextual areas and supportive of lifelong learning would be the result (Dewey, 1938; Roberts & Ball, 2009). As stated by Roberts and Ball (2009), agricultural educators already incorporate curriculum from other academic areas designed to support agricultural content.

Specifically, research conducted by Parr, Edwards, and Leising (2006; 2009) stressed the integration of math-related concepts in agricultural power and technology curriculum. The study by Parr et al. (2006) sought to

> . . . empirically test the hypothesis that students who participated in a contextualized, mathematics-enhanced high school agricultural power and technology curriculum and aligned instructional approach would develop a deeper and more sustained understanding of selected mathematical concepts than those students who participated in the traditional curriculum and instruction.
> (p. 81)

It was determined that the math-enhanced curriculum and instructional approach had a statistically significant effect ($p < .05$) on the need for remediation in mathematics at the post-secondary level as a result of the intervention.

Additional research by Parr et al. (2009) sought to determine the effect that a math-enhanced curriculum and instructional approach, aligned to standards required by the state of Oklahoma, would have on a student's ability to understand general and workplace mathematics as compared to those students not receiving the treatment. As a result of the treatment, a statistical significance ($p < .05$) was not found. It was noted however, that complete implementation of the protocol did not occur resulting in the recommendation of a year-long replication of the study (Parr et al., 2009).

Scientific principles specific to agricultural curriculum has also been identified by other researchers. Balschweid, Thompson, and Cole (2000) sought to determine if an integrated science and agriculture curriculum that was delivered to pre-service teachers at Oregon State University increased their desire to integrate their own curriculum with increased collaboration after their pre-service teaching experience. Moreover, it was hoped that this curricular intervention would be a catalyst towards potential collaboration efforts with core curriculum teachers upon the onset of the pre-service teachers' careers.

As a result of the study, a positive inclination for the participants to seek collaborative efforts with their future colleagues and to institute the inclusion of science-related concepts into their curriculum was found.

Research conducted by Chiasson and Burnett (2001) emphasized the impact that agriscience courses had on the science achievement of high school students. The research population consisted of eleventh grade students who had completed the Louisiana-mandated state exit proficiency examination in science. A comparison of agriscience students' science proficiency with those students who were not enrolled in agriscience coursework was sought. It was determined that those students enrolled in agriscience coursework scored higher on the state-mandated science examination than those students with no agriscience coursework experience.

Balschweid (2002) studied the perceptions of high school students after completing a year-long biology course devoted to the study of animal science. During the course of his investigation, he found that 90% of those biology students engaged in a contextualized course delivery emphasizing animal science concepts understood those scientific concepts better. Moreover, it was determined that more than 85% of those students who were enrolled in the course had an appreciation for those concepts and principles of animal science as a result of participating in the contextualized learning process (Balschweid, 2002).

Balschweid and Thompson (2002) investigated the impact of the integration of science on agricultural education programs in Indiana. Perceptions of agricultural science and business teachers were determined through an "Integrating Science Survey" questionnaire. A positive response was experienced by the participants regarding the integration of science into the agricultural curriculum. It was also determined that their study had a positive influence on the institution of select agricultural education courses for science credit for high school graduation and was identified as a viable means of receiving credit by more than one-half of the research participants.

Roegge and Russell (1990) sought to determine the compatibility of biology and agriculture when integrated in the secondary school setting. Biological principles were incorporated into the agriculture curriculum to accomplish the purpose of the study. The researchers collected data regarding student attitudes and achievement as a result of the integration of the biological and agricultural principles. The population consisted of all schools in Illinois that offered a comprehensive program of production agriculture. The study utilized a pretest – posttest control group design with an experimental group that received lesson plans and accompanying materials (i.e., the treatment) for the targeted curricular area.

It was determined that the experimental group members had a more positive agricultural attitude than the comparison group post treatment. Further, as a result of the biology posttest administered during the research, it was found that the mean test scores of those students receiving the intervention were higher than the students' comparison group thereby resulting in the rejection of the researchers' null hypotheses $HO_2$.

Finally, the authors identified that there existed a statistically significant attitude difference (i.e., $p < .05$) toward the integrated instruction by the experimental group (integrated approach) as compared to the comparison group (traditional approach). A 20 item instrument was designed to measure students' attitudes. Through the administration of the instrument, the researchers determined that there was a statistically significant difference in attitude toward the integrated curricular approach which was being used resulting in rejection of null hypotheses $HO_3$.

A 1995 study by Connors and Elliot sought to determine if teaching scientific concepts utilizing an animal and plant science or natural resources curriculum would support an increase in student science interest. Using a standardized achievement test in high school biology, it was determined that no statistical difference existed in science aptitude between those students enrolled in agriscience and natural resources and those students who were not enrolled in those courses.

Ricketts, Duncan, and Peake (2006) sought to determine the level of science achievement of students in Georgia who enrolled in departments of agriculture with complete programs of agriscience. Further, the researchers sought to compare the science achievement of students who were on a college preparatory track with those students who were classified as being on a "dual track" (i.e., enrolled in courses that were directed at technology and career preparation). It was determined through the Georgia High School Graduation Test (GHSGT) that 78% of agriscience students passed the examination on their first attempt, compared to a state average of 68% and 38% of those students who were in a technology and career preparation track. Further, it was revealed through the GHSGT, that the mean score of agriscience students ($M$ = 511.24) was only three points lower ($M$ = 514.85) than those students who were pursuing a college preparatory program.

Thompson and Balschweid (2000) sought to determine the attitudes that agricultural science and technology teachers had toward integrating science into their curriculum and programs. The population for this study consisted of all agricultural science and technology teachers in Oregon who were certified. It was concluded that a positive attitude among the research participants toward the integration of science into programs of agricultural education existed. Moreover, the teachers perceived that students were prepared to understand scientific concepts better as a result of that integration.

This section highlighted the extensive research that has been conducted with regard to the needs of individuals concerning scientific literacy. Mabie and Baker (1996) identified that activities where students can develop their agricultural skills, while reinforcing their science abilities, is contextually transferable across animal and plant science. Combined with Dewey's opinion that students should be educated for future success through the holistic blending of academic and vocational skills, the potential for scientific achievement through an agricultural curriculum rich in botany and zoology principles is evident.

## Student Science Learning and Achievement

### *National Science Standards*

It was identified by the National Commission on Education (1983) that, "Our nation is at risk. Our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world" (p. 112). With the 1957 launch of Sputnik by the Soviet Union, effective science instruction has been the subject of intense discussion in educational circles (Dana, Campbell, & Lunetta, 1997). Because science learning is considered a "critical objective of modern schooling" (p. 385), new developments in effective science instructional methods are becoming increasingly important (Woolsey & Bellamy, 1997). Opportunities in the use of technology have become increasingly commonplace in the school system, and the use of computers and their applications are finding their way into effective science instruction (Woolsey & Bellamy). The relationships of observation and reporting, phenomena and media, analysis and mathematical capabilities and the collaborative efforts of inquiry and computer technology are key relationships for increased science learning (Woolsey & Bellamy).

The U.S. General Accounting Office (1994) identified that graduates of our nation's high schools are "scientifically and technologically illiterate" (p. 1), and that an extensive gap exists between the performance of students of other nations and U.S. students regarding the area of science. Since 1969, science achievement scores of 17 year-old students in the United States have been in steady decline (National Commission on Excellence in Education, 1983; National Science Foundation, 2006). As such, the "A Nation at Risk" report was created to stress scientific concepts valued most by society (National Commission on Excellence in Education, 1983). Those concepts include "a) the concepts, laws and processes of the physical and biological sciences; b) the methods of scientific inquiry and reasoning; c) the application of science knowledge to everyday life; and d) the social and also environmental implications of scientific and technological development" (p. 25). Collins (1998), in *National Science Education Standards: A Political Document*, stated that curricular experimentation and instruction and assessment experimentation was needed for the valued societal scientific concepts to be attained. A focus on the needs of students' development should be a concern placed above an adherence to the instructional delivery methods of the past (Dana, Campbell, & Lunetta, 1997).

*Science, Technology, Engineering, and Mathematics (STEM)*

The beginning of the twentieth century saw scientific knowledge held up as the solution to the world's problems and the provider of new discoveries for an increasingly industrialized society (Brinkley, 2009). However, both with the onset of two world wars and an economic worldwide depression period, it was doubted that scientific inquiry could solve all of the world's problems. A new emphasis on humanistic studies was welcomed as a new way to ensure that democracy continued in an ever-changing world (Brinkley). With a philosophical change in the United States' approach to world diplomacy, it was evident that the Nation was beginning to lag behind countries such as China, India, and Japan in science, technology, engineering, and mathematics (STEM) academic areas (Brinkley, 2009). It is also evident that the United States needed to embrace STEM education initiatives coupled with humanities education to remain competitive in an ever-changing world.

Concerned that the United States was lagging in areas involving STEM compared to other countries, an increased emphasis for STEM literacy became prevalent on the national level ("President Obama launches 'Educate *to* Innovate' campaign for excellence in science, technology, engineering & math (STEM) education," 2009, November). This initiative includes' the development of public-private partnerships that emphasizes opportunities in hands-on learning, the use of interactive games, and media recognition. The initiative also stresses the recruitment of private sector leaders such as the Bill and Melinda Gates Foundation as well as the Carnegie Corporation to increase public awareness of the importance of STEM on the national level and the acknowledgment of STEM efforts by students through an annual science fair held at the White House showcasing student winners in national competitions ("President Obama launches 'Educate *to* Innovate' campaign for excellence in science, technology, engineering & math (STEM) education," 2009, November).

A concern for students being "out-performed" in STEM areas by students of other nations, and the expansion of opportunities for those under- represented populations such as women and minorities in STEM education is a major concern. Three priorities were established by President Obama in his quest to increase STEM literacy. The development of increased STEM literacy and student proficiency requires an increase in the quality of teachers in the areas of math and science, and through the expansion of career and educational opportunities for women and minorities ("President Obama launches 'Educate *to* Innovate' campaign for excellence in science, technology, engineering & math (STEM) education," 2009, November).

During the 1980 s, agricultural education was called on to increase the integration of science competencies in its curriculum (Phipps, Osborne, Dyer, & Ball, 2008). As a result of *Understanding Agriculture: New Directions for Education*, the National Research Council (1988) identified sweeping changes to agricultural education as a consequence of the integration of science into the curriculum, resulting in an abundance of research targeting this integration (National Research Council, 1988). As an outcome of this publication, emphasis increased to align science standards with agriculture curriculum resulted in the curriculum of agricultural sciences education model (CASE). This curriculum emphasized the cross-walking of secondary agricultural education curriculum with science, mathematics, and communication arts with respective national and state standards associated with those curriculums. This provided a new and attractive program of agricultural education designed to align with the components of STEM while remaining mired in the Agriculture, Food and Natural Resources career cluster areas (Team AGED, 2007).

*Contextual Teaching and Learning (CTL) and Problem-Based Learning in Science Education*

Recent reform efforts in science education have provided enhancement to teacher in-service opportunities regarding potential challenges that may exist in their daily pedagogical practices (Meijer, Zanting, & Verloop, 2002). "Contextual teaching and learning (CTL) integrates inquiry, problem-, and project-based learning, cooperative learning, and authentic assessment" (Glynn & Winter, 2004, p. 51). CTL takes into account the diverse life experiences of students with regard to learning in a complex environment (Glynn & Winter, 2004). Research by Glynn and Winter (2004) identified different CTL strategies and conditions which might hinder their potential implementation.

The researchers identified five different strategies that were implemented routinely more than the others (Glynn & Winter, 2004). Those strategies included: 1) Inquiry learning, where students are encouraged to learn science principles through natural investigation; 2) Problem-based learning, where students obtain resources from different contextual experiences in conjunction with critical thinking to solve problems; 3) Cooperative learning, where small group work and focus toward a common goal is emphasized; 4) Project-based learning, where collaborative or independent projects that are of interest to students are conducted; and 5) Authentic assessment, where performance is driven by assessment with regard to students' relevant, real-life, practical application (Glynn & Winter, 2004).

The researchers conducted a two-week workshop to emphasize CTL strategies in physical and life sciences lessons. After the workshop concluded, teachers were assessed throughout the school year to determine how they implemented CTL strategies in their lessons. Through a case study approach, it was determined that CTL strategies provided teachers with an instructional approach that provided relevance for their students with regard to science (Glynn & Winter, 2004). However, when sound classroom management practices were abandoned by teachers when using CTL strategies, a breakdown in student behavior occurred (Loucks-Horsley, Lovie, Stiles, Mundry, & Hewson, 2003; Glynn & Winter, 2004).

Gallagher, Stepien, Sher, and Workman (1995) identified how problem-based learning (PBL) was used in the high school and elementary school settings. Although, originally designed for graduate school medical programs, PBL is being used in secondary classrooms to allow students to experience science education just as it could be experienced in the "real world" (Gallagher et al., 1995).

It was discovered that exposure to the complete milieu of a scientist benefitted science education more than just through experimentation through learned principles. “Problem-based learning inverts the order of learning procedures to make it reflect much more realistically the learning and problem solving that occurs in professional practice” (Gallagher et al., p. 137). Whereas students take on the lead role in learning acquisition, teachers become facilitators and metacognitive coaches and aid students through problems that they encounter during their investigation (Barrows, 1988).

*Professional Development for Teachers*

There is a distinct contrast in the educational standards between the United States and other countries. Although the United States spends one-half of its educational funds on activities and personnel outside of the classroom, other countries invest in their children’s future significantly by providing most of their educational dollars toward the preparation and support of their teachers (Darling-Hammond, 1996). Darling-Hammond identified that, “a lack of standards for students and teachers, coupled with schools that are organized for 19th century learning, leaves educators without an adequate foundation for constructing good teaching” (p. 193).

Some of the current barriers to student learning include 1) unequal resources and poor funding for recruiting teachers; 2) the employment of unprepared or under-prepared teachers; 3) deficiencies in teacher education programs; 4) inefficient hiring and training practices; and 5) the lack of professional development for beginning and seasoned teachers (Darling-Hammond, 1996). “In addition to the lack of support for beginning teachers, most school districts invest little for ongoing professional development for experienced teachers and spend much of these limited resources on unproductive 'hit-and-run' workshops" (Darling-Hammond, 1996, p. 195). It has been identified, however, that providing prolonged, sustained professional development in conjunction with teacher quality is an excellent predictor of student success (Sullivan, 1999).

Little (1993) identified six principles for professional development. 1) That professional development provides teachers with an intelligent, meaningful, presentation and collaboration of ideas with colleagues both in and out of education; 2) That professional development accounts for teacher experiences and context in development; 3) That professional development takes into consideration the differences and values of those who participate; 4) That professional development considers the practices at the classroom level equally with those at the school level and with the consideration of a child's educational career; 5) That professional development supports and encourages the practice of educational inquiry; and 6) That professional development maintains a balance between institutional interests and those of the teachers (Little, 1993).

*Using Technology as a Tool to Teach Science in 21st Century Classrooms*

Agricultural education has evolved from what is perceived to be strictly an instruction source for "sows, cows, and plows." Educational institutions have a variety of resources from which to draw information that reinforces rigor in the modern classroom. Although text-based information is a standard valuable resource in the classroom, educators now utilize the Internet to embrace audio and video resources and other methods of instructional delivery common in the 21st Century classroom (Brashears, Akers, & Smith, 2005).

“Today’s students are no longer the people our educational system was designed to teach” (Prensky, 2001a, p. 1). Today’s students are more adept at using cellular phones, compact disk players, computers, and video games because they have spent much of their lives exposed to these forms of technology (McAlister, 2009; Prensky, 2001a). Prensky estimated that today’s college graduate has spent in excess of 30,000 hours immersed in playing video games and watching television, compared to 5,000 hours of their lives engaged in reading. As such, Prensky (2001b) opined that the millennial’s brain is in fact “hardwired” differently than those of the “baby boomer” generation. Previous research has identified that the brain is organized and changes according to the sensory inputs and the way the brain makes meaning of its surroundings (Caine & Caine, 1989, 1990).

Students today are referred to commonly as “Digital Natives” (Prensky, 2001a). Digital natives are those individuals who were born between 1980 and 1994 (Bennet et al, 2008, Prensky, 2001a). They use technology for the different tasks that comprise their typical day (Herther, 2009). Moreover, digital natives are adaptable and willing to transform and adapt to the tools that change for the task at hand. Unlike the “Digital Immigrant,” who will use the technology that is available to them when needed, although not totally familiar with all of the “bells and whistles” associated with it, the digital native is not in "tune" with those technologies not associated with the digital age. Educationally, this generation perceives traditional pedagogical methods as similar to a foreign language (Herther). Specifically, “[t]hey [Natives] often can’t understand what the Immigrants are saying” (p. 16).

Because of the Digital Age, classrooms of today depend more on learning environments that utilize interactive approaches to education (Brazen & Clark, 2005). Those teachers who continue to rely solely on the lecture format of instruction as they were taught are deemed less effective in the classroom (Brazen & Clark). An active learning environment, one where the student has control of the learning at hand, has been found to enhance critical thinking skill development (Borg & Borg, 2001; Slavin, 1996; Youngblood & Beitz, 2001).

A study by Oliver-Hoyo, Allen, Hunt, Hutson and Pitts (2004) examined the effect that students enrolled in an undergraduate general chemistry course had on critical thinking skill development. A program known as Student-Centered Activities for Large Enrollment-Undergraduate Programs (SCALE-UP) developed at North Carolina State University was initiated to integrate a Lecture-Lab component in an introductory chemistry course. The need for this study was evident with research identifying where instructional and evaluative methods associated with student learning was in need of a "philosophical shift" to match student learning needs (Loyd, 1992).

The SCALE-UP approach to curricular and delivery change emphasized a decrease in lecture time and optimized student-centered learning in hands-on laboratory activities. An emphasis was placed on collaborative work in a seamlessly integrated lecture and lab learning environment (Oliver-Hoyo & Allen, 2005) along with the use of technologically advanced instruction (i.e., laptops, whiteboards, multimedia projectors). Although controversy exists as to the effectiveness of computers in education (Bork, 1995), research indicates that when used in ways other than just for the display of instructional material, an improved understanding of the subject matter by students occurs (Stolow & Joncas, 1980).

Data gaps occurred as a result of some students not participating in all of the testing opportunities in the SCALE-UP study. As a result of this lack of data, those individuals who did not complete all of the required analysis points successfully were eliminated from the statistical analysis. Through analyzing test scores on four major examinations, the results of the study indicated that a statistically significant level of improvement in performance occurred for the students in the integrated lecture/laboratory learning environment (Oliver-Hoyo, et al., 2004) when compared to those students who were only instructed utilizing the traditional lecture format.

Research by Brashears, Akers, and Smith (2005) regarding the effects of multimedia cues on student cognition in an electronically delivered high school unit of instruction stated that, "the development of electronic curriculum materials holds great promise and rewards for both educators and learners alike. . ." (p. 5). The researchers tested and evaluated the cue-summation theory. Cue-summation can be described as an instructional delivery method involving "multiple cues across multiple channels" (Brashears et al., 2005, p. 5). Students were exposed to three treatments (single cue (text only), redundancy (text with an audio/video component), and cue-summation (audio/video and still images) to test the theory. The researcher found there was a statistically significant difference ($p = < .000$) between those students who received the text only treatment and those students who received the text incorporated with the audio/video element. According to Brashears et al. (2005), ". . . students who were administered Txs [treatments] containing multiple cues performed significantly higher than students who received only a single cue" (Brashears et al., 2005, p. 15), indicating that classroom instruction might benefit from this model of instructional delivery.

It was identified in this section that science is considered a "critical objective of modern schooling" (Woolsey & Bellamy, 1997, p. 385), and as a result, new and effective instructional methods in science are becoming increasingly essential. With the use of computers and their applications finding their way into the instruction of scientific concepts (Woolsey & Bellamy), technology, especially as a means of curricular experimentation (Collins, 1998), has become commonplace in the school system. Additionally, two specific instructional methods were identified to increase student cognition in science. Both of the methods, contextual teaching and learning and problem-based learning, place the student in the role of the investigator, while the teacher serves as the metacognitive coach and a resource to guide and aid student learning. Finally, by providing teachers with professional development gauged upon their experiences and adherence to the six principles for professional development as espoused by Little (1993), teachers can be prepared better to help their students succeed (Darling-Hammond, 1996).

## Curriculum Integration to Improve Student Learning and Achievement

### *Content Integration*

Not all students learn the same, nor should that be expected. The acquisition of knowledge by the learner is unique to the individual and speaks to the different modalities of learning (i.e., auditory, kinesthetic, and visual) (Savitz, 1999). Howard Gardner's theory of multiple intelligences assumes more than one way to learn and that educators need to tap into those different ways to make learning meaningful to all students (Checkley, 1997).

Macaulay, Van Damme, and Walker (2008) identified that a “blended” curriculum included different modalities in the presentation or instruction process. Presentation skills such as online, face-to-face learning opportunities and instruction in lecture and laboratory environments accentuate the different learning styles of students and enhance the contextualized learning process.

Contextualized learning is a concept whereby individuals make relevant meaning out of the experiences they gain through the learning process (Putnam, 2001). Edling (1993) stated that, “Learning is greatly strengthened if concrete examples or situations familiar to the student can be brought in to play in the learning process” (Contextual learning section, para. 2).

Students learn best when they can relate the information presented to them in such a way that it resonates with their personal experiences. A lesson describing the environmental impact of water pollution is more likely to have a much deeper meaning for many learners when presented by a littered stream than it would through lecture in the classroom because, “Meaning of the information depends upon the context in which the information will be used” (Putnam, 2001, p. 2).

For students to exhibit the effective transfer of information from one course to another, a relationship must be developed between the learning and the learner. Edling (1993) posited that the cognitive transfer of learning is a learned behavior and that motivation of the student through active participation in a contextualized environment involving the subject matter is essential in developing those skills. Edling posited that a quality education must be focused and contextualized to produce graduates who are prepared to enter the workforce or higher education.

Learners benefit from the contextualized learning process through real-life experiences that guide instruction in a way they learn best (Macaulay et al., 2008). Macaulay et al. identified students who were engaged in active learning through a contextual study of a biochemistry course for dietetic students. The authors found that a blended curriculum, which catered to different learning styles with problem solving and case study activities, was deemed intellectually stimulating by 89% of the participants. As such, when learning experiences are approached from a holistic viewpoint, more complex cognitive schema are developed, thereby increasing understanding (Reigeluth, 1999).

A variety of learning modalities must be accommodated when planning a contextualized learning experience for students to include aspects of cultural and educational diversity (Tate & DeBroux, 2001). To that end, learning experiences need to be developed that will meet these different diversity needs (Tate & DeBroux).

*Contextualized Learning in Agriculture*

The need for instruction to match how students' learn best is of the utmost importance in today's assessment-driven educational climate. The impact of "No Child Left Behind" (Apple, 2006) has dictated that classrooms "teach to the test" (Ricketts et al., 2006, p. 48) to satisfy educational accountability requirements as passed by law.

The National Commission on Mathematics and Science (2000) has stated that student performance in science is unacceptable. Because of the increasing concern of the low performance in the area of science, it is imperative that increased efforts be focused on reinforcing scientific principles, which are found "naturally" in the agricultural education curriculum, through curricular integration (Balschweid et al., 2000; Balschweid, 2002; Balschweid & Thompson, 2002; Balschweid & Huerta, 2008; Chiasson & Burnett, 2001; Connors & Elliot, 1995; Fraze, 1993; Ramsey & Edwards, 2004; Ricketts et al., 2006; Roegge & Russell, 1990; Thompson & Balschweid, 2000).

Lewis and Overman (2008) determined that students who found interest in occupational areas through CTE coursework benefited from an increase in their academic performance as a result of the curricular integration that was involved. Further, the authors concluded that those students who experienced an increase in their academic skills were prepared better for postsecondary education; thus, the need for remedial education was less likely.

Agricultural education is the ideal medium for teaching a contextualized curriculum for a variety of content areas including science (Balschweid, 2002), mathematics (Parr, Edwards, & Leising, 2008), and reading comprehension principles (Park & Osborne, 2007). According to Phipps et al. (2008), the context of agriculture is an ideal medium for scientific thought, and a deeper engagement of learning and understanding occurs as a result of the "marriage" of theory and application.

It also has been identified that instruction in agricultural education should include a component devoted to the teaching of combined agricultural and scientific concepts through both classroom and laboratory instruction (Balschweid, 2002; Roegge & Russell, 1990). Balschweid (2002) stated that, "They [students] need exposure to multiple opportunities for thinking scientifically, and multiple opportunities for applying scientific reasoning to everyday, complex problems" (p. 57). This practice reinforces further the agricultural education curriculum as one suitable for cross-curricular instruction.

Students who are otherwise disinterested in science through traditional instruction may find relevance in science education taught in other contexts (Balschweid, 2002). Balschweid found that almost 80% of students who participated in a traditional biology course using agriculture as the context developed a moderate to high interest in agriculture and food systems, while 81% of the students involved in the study scored a grade of either an "A" or "B" in the contextually-driven course.

An example relevant to agricultural education being an ideal content and context for learning is found in the agricultural education model developed by Roberts and Ball (2009). The model developed by Roberts and Ball (Figure 1) identifies how knowledge that is utilized from across domains combined with an industry-validated agricultural curricula serves as an excellent vehicle to facilitate learning between the learner and the educator, moreover, producing agriculturally literate citizens and a skilled agricultural workforce (Roberts & Ball, 2009).

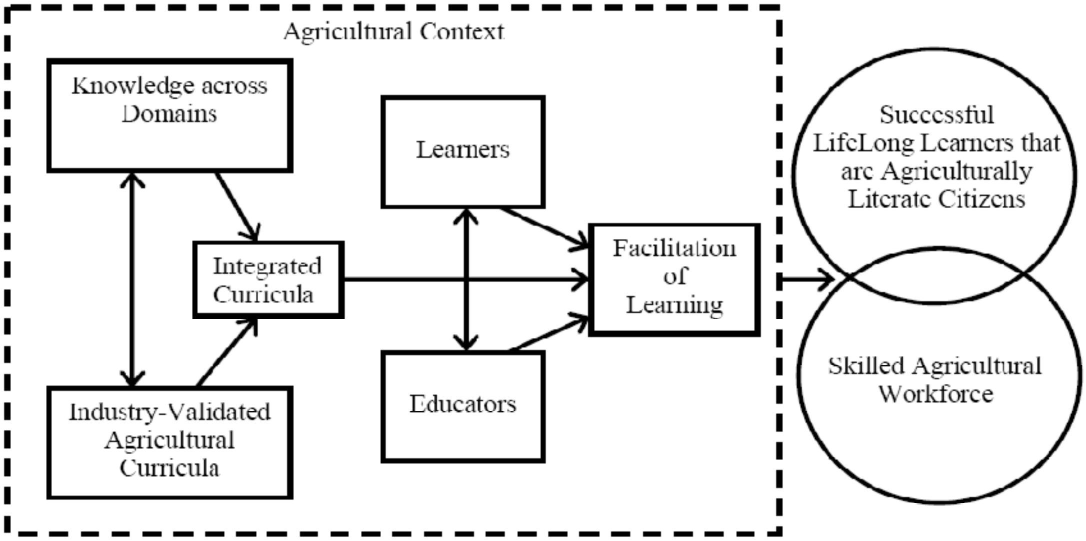


*Figure 1.* Conceptual model for agricultural subject matter as a content and context for teaching. (Taken from Roberts & Ball, 2009)

The three circles (i.e., Venn diagram) of a comprehensive agricultural education model integrate classroom and laboratory instruction, supervised agricultural experience (SAE), and the FFA (Jenkins & Kitchel, 2009). This approach allows educators to connect contextual learning in the agricultural education program, making it ideal for teaching across curriculum areas. Dewey (1938) stated that, “Perhaps the greatest of all pedagogical fallacies is the notion that a person learns only the particular thing he is studying at the time” (p. 49-50). Dewey’s statement reinforces the concept of experiential learning across and within different learning dimensions or subjects as an ideal contextual learning medium, including students’ performance involving knowledge and understanding of science.

*Agricultural Literacy*

The importance of an agriculturally literate society cannot be underestimated. According to D'Arcangelo (2002), in order for students to be successful in their careers and their personal lives, they must be literate and able to apply those skills and make use of the information and knowledge available to them in the world today. This applies to students across all academic fields including agricultural education (Park & Osborne, 2006).

The National Research Council (NRC) (1988) identified the need for agricultural literacy instruction for all students from kindergarten through twelfth grade. NRC determined that 6% of the population in America's schools completed coursework in agriculture successfully. As a result, it is essential that curriculum be developed to assist all students in making informed choices regarding the agricultural industry (NCAE, 1999). Since "food is a common denominator for all children, [it] is a useful way to get children's attention about agriculture" (NRC, 1998, p. 2).

*Science Integration in Agricultural Education*

In numerous states, science credit is, or potentially could be offered for students who complete courses in agriscience education successfully (Fraze, 1993). In a study by Chiasson and Burnett (2001), it was determined by science end-of-course instructional tests that agriscience students outperformed non agriscience students on Louisiana's high stakes test for science. It was concluded that students in Louisiana could enroll in an agriscience course to satisfy the state's science proficiency requirement. Balschweid and Thompson (2002) have also supported the notion that integrating applied learning and academic concepts can improve student competency in the sciences, thus, justifying the call for science content integration.

The blending of agricultural content and context (Roberts & Ball, 2009) with scientific principles benefits those students who have become disinterested in the learning of science through traditional means (Balschweid, 2002), and those students may actually benefit from the scientific principles learned, allowing them to better understand the relationship between agriculture and science. This increased learning may be the result of integrating classroom and laboratory contextual experiences that are rich in science.

In a survey of agricultural science and business teachers in Indiana, it was asserted that, "people pursuing a career in agriculture must have a greater understanding of biological science than ten years ago" (Balschweid & Thompson, 2002, p. 4). The authors further identified that Indiana agricultural science teachers perceived they were prepared to teach scientific principles and concepts in their agricultural programs. However, they perceived that their biggest barrier to teaching science in agricultural education was the lack of proper facilities and supplies needed to instruct science properly.

*Science-Enhanced Curriculum in Agricultural Education*

According to the report, *Understanding Agriculture: New Directions for Education* (1988), agricultural education curriculum had failed to stay current with modern agriculture. In a curriculum area that is naturally rich with scientific concepts, agricultural education could provide a great service to public education by helping students improve their understanding of science through an agricultural context.

Roegge and Russell (1990) reported that students who were instructed with a curriculum which contained a blended approach to agricultural and biological education exhibited a higher level of understanding of those principles than students who were taught using traditional means. To that end, it has been suggested that integrating science into agricultural education curriculum is a more effective way to teach science (Chiasson & Burnett, 2001; Dyer & Osborne, 1999; National Research Council, 1988; Roegge & Russell, 1990). Further, it can be implied that teaching science in the context of agriculture can enhance all students' learning in science regardless of age. Mabie and Baker (1996) found that elementary students who were taught science skills through the context of agriculture had an increased level of science achievement.

A science-enhanced curriculum in agricultural education suggests that students involved in this form of science instruction would benefit greatly toward passing the growing number of state examinations required as a result of "No Child Left Behind" and similar legislation (Apple, 2006). Ricketts et al. (2006) found that 78% of Georgia agriscience students who were instructed in a complete program of agriscience that took the Georgia high school graduation test (GHSGT) in science passed the test on the first time compared to a state-wide average of only 68%. Additional research indicated that students who participated in agriscience coursework and related activities in the area of science outscored those students who did not (Chiasson & Burnett, 2001; Conroy & Walker, 1998; Mabie & Baker, 1996).

*Center for Agricultural and Environmental Research and Training (CAERT) Curriculum*

The curriculum intervention utilized in this study was developed by the Center for Agricultural and Environmental Research and Training (CAERT). The mission of this organization is to provide educational science-based materials in agricultural and environmental instructional areas (CAERT, 2010a). To help convey scientific principles in the context of agriculture, the Center for Agricultural and Environmental Research and Training (CAERT) provides agriculturally based, science-enhanced materials for use in agricultural and environmental instruction at the secondary level. Specializing in activities that are collaborative, students of agricultural education are provided with a technologically-enhanced curriculum where they are actively involved and engaged in the learning process, with an emphasis on science (CAERT, 2010a).

The ODCTE contracted with CAERT to develop curriculum suitable to meet the Priority Academic Student Skills (PASS) guidelines of the Oklahoma State Department of Education [OSDE] (2010b) in the area of science. Specifically, CAERT curriculum was developed and cross-walked to meet the academic learning standards in the content areas of Animal Science, Plant and Soil Science, and Horticulture (K. Murray, personal communication, October 1, 2009).

The science-enhanced, CAERT curriculum was cross-walked with Oklahoma PASS skills by a committee made up of agricultural educators, teacher educators, state staff, and curriculum specialists (D. Pentony, personal communication, December 6, 2010). The cost of the curriculum is associated with which components are selected for use (D. Pentony, personal communication, December 6, 2010). Current prices for both the horticulture and animal science curriculums are by subscription on a yearly basis. Cost for the lesson plans with accompanying PowerPoints® and academic alignments are $179.95. Online student text materials (E – Units) designed to support the lesson plans are $199.95. The online assessment component encompassing over 4000 questions is

$399.95. Total cost for one set of curricular materials is $779.85 (D. Pentony, personal communication, December 6, 2010).

This section identified specific research regarding efforts to improve student learning and achievement in science through curricular integration, with an emphasis on science literacy. With rising concern over low student achievement in science, focused efforts on the reinforcement of scientific principles in the context of agricultural education is essential (Balschweid et al., 2000; Lewis & Overman, 2008).

## Socioeconomic Status and Student Academic Achievement

Socioeconomic status (SES) has been linked in educational research to student achievement. In fact, SES was identified as having had an influence on a child's academic achievement since the mid 1960 s (Coleman et al., 1966). Moreover, it has been identified that the SES of a family, as well as the community of residence, can play a significant role in the academic success of a student. Further, students who attend schools with a higher mean SES are more likely to succeed in an academic setting then those with a lower mean SES (Caldas & Bankston, 1997; Ho & Williams, 1996). Peer association also has been related with SES because of the propensity of students with the same social standing and socioeconomic characteristics to attend the same schools (Caldas & Bankston, 1997). Caldas and Bankston (1997) concluded that,

> . . . given the recognized importance of peer groups for shaping adolescent behavior, a knowledge of the class and economic background of peers can make a significant contribution to our ability to predict individual achievement that is independent of the class and economic backgrounds of the individuals. (p. 270)

It has been suggested that a person's "capital" (i.e., financial, human, and social) may be the best way to identify and predict student success (Milne & Plourde, 2006). Caldas and Bankston (1997) described four factors that have an independent effect on a student's academic achievement: 1) income status of the family and how that income may be associated with educational capital acquired and used by students in the home (i.e., educational materials, computers, Internet access), 2) the educational backgrounds of the family and those educational traits brought to the school social environment by the student, 3) family occupational background, 4) the direct and indirect effects that school faculty and administrators perceive of the abilities of the student and their peer groups.

Additionally, poor academic achievement and family income has been correlated positively with SES (Haveman & Wolfe, 1995). A study conducted by Duncan, Yeung, Brooks-Gunn, and Smith (1998) sought to determine how childhood poverty affected the life chances of children. The researchers found that, "Children in families with incomes less than one-half of the poverty line were found to score between 6 and 13 points lower on the various standardized tests" they completed (p. 408). Moreover, those students coming from an environment with a high poverty classification fall behind their peers regarding problem solving skills and are less prepared to learn when they enter school (Vail, 2004).

In a comparison made by Bradley and Corwyn (2002), those students classified as coming from low SES households were less likely to have been provided educational material in the home that reinforced the material they were learning. In addition, exposure and regulation of television programming quantity and quality that could have been used better did not occur. In support, Stevenson and Baker (1987) posited that those students who came from high socioeconomic households had better access to books and other educational opportunities. Accordingly, they concluded that, a higher likelihood of parental involvement existed where there was a level of academic success in the children's schooling. Further, students from high socioeconomic households are offered additional opportunities for deeper and engaged conversation with their parents, while low socioeconomic students are expected to not interrupt adult conversations (Bradley & Corwyn, 2002).

The Bureau of Census (2009) found that 26.3% of all children in the United States under the age of 21 lived in a single parent household. It has been noted that, in single parent families, students will have less of a tendency to complete high school and pursue higher education (Lillard & Gerner, 1999). This factor compounds the effects that SES will have on academic achievement, impacting the well-being of the child significantly (Caldas & Bankston, 1999). Caldas (1999) identified in a study on tenth graders taking the Louisiana Graduation Exit Examination (LGEE) that socioeconomic status explained 45.5% of the variance in test scores between school districts. In addition, students' scores from single parent households accounted for 96% of that variation, providing a stronger negative influence on school academic achievement than either poverty or race (1999).

A study by Milne and Plourde (2006) cited the U.S. Census Bureau as reporting that the 2002 poverty rates for children were as high as they had ever been. This finding translates into a higher percentage of students who were raised in households with a low SES. Current 2009 published data indicated this had been surpassed with a 20.7 percent poverty rate for children under the age of 18 which comprised 35.5 percent of the total amount of people living in poverty conditions (Bureau of Census, 2009). Combined with research that indicates how a child's academic ability and cognitive capacity are affected by socioeconomic status, this has become an "escalating imperative" that must be addressed (Bradley & Corwyn, 2002; Duncan, Yeung, Brooks-Gunn, & Smith, 1998).

Sirin (2005) stated that a school's SES is measured by the number of students participating in the free and reduced lunch program at that school. Those students with family incomes designated to be at 130% of the poverty level become eligible for free meals, while those between 130 and 185% of the designated level qualify for reduced lunch meal prices. When considering those students involved in the federally funded free and reduced lunch program, it was determined that this factor (SES) was considered to be a reliable predictor of school test scores, regardless of the type of test given (Thomas & Stockton, 2003). Additionally a study conducted by the Louisiana Department of Education (2001) revealed it was twice as likely for students receiving free and reduced lunch services to be held back in grade than those not participating in the program.

This section identified key factors regarding SES and the role it plays in the academic success of students. Researchers identified children with incomes below one-half of the poverty line scored lower than their peers on various standardized tests (Duncan, Yeung, Brooks-Gunn, & Smith, 1998). Students from high SES households were found to have a higher level of parental engagement, increasing their chances of academic success (Bradley & Corwyn, 2002). Since academic ability and cognitive capacity are affected by SES, the advantages of a curricular integration are obvious in student science achievement.

## Conceptual/Theoretical Framework

The importance of agricultural education as a method of contextual learning to reinforce scientific principles in education is potentially significant. During the 2002 Association for Career and Technical Education Conference, Carol D'Amico, then Assistant Secretary for Vocational and Adult Education stated that, "Vocational education will maintain its indispensable place within the larger American educational establishment. It can achieve greater integration with, and prominence within, that larger framework, as it aggressively embraces the challenge to raise the bar of academic achievement" (Martin, Fritzsche, & Ball, 2006, p. 100). However, for curricular integration to have a positive effect on student learning, the brain must be engaged.

This study was undergirded by the constructivism and brain-based learning (BBL) theories whereby people learn in authentic environments by connecting their learning to prior knowledge (Doolittle & Camp, 1999). The constructivist theory, according to Brown (1998), as cited in Parr et al. (2009), relies on strategies of implementation such as, "student-centered teaching, project-oriented instruction, problem-based learning, and contextual teaching and learning" (p. 59). Brown (1998) stated that, "In constructivism, the focus of teaching is on empowering learners to "construct new knowledge" by providing opportunities for them to test academic theories through real-world applications of knowledge in settings that are socially relevant to their lives" (p. 3).

The brain is an amazing regulatory device of the human body. It directs movements, abilities in verbal and non-verbal communication, and selective functions of the body. As such, Caine and Caine recommended that teachers utilize all possible resources to make learning "real." Due to the nature of this study, the theoretical underpinnings for this research were drawn from selected tenets of brain-based learning.

Bellah et al. (2008), relying on research undertaken by Caine and Caine, (1994) stated that the brain makes associations that triggers synaptic connections as a result of contextual experiences. These contextual experiences are unique, but contain relevant points of continuity that transfer from each distinctive learning experience (Caine & Caine). Specifically, it is evident that the primary goal should be for educators, as well as learners, to move away from the concept of memorization and to embrace approaches to meaningful learning (Bellah et al., 2008). For this to occur, the brain must be relaxed, immersed, and active (Caine & Caine, 1989).

The brain factors "thoughts, emotions, imagination, and predispositions" (Caine & Caine, 1990, p. 66) in a seamless fashion; therefore, the concept of contextual teaching and learning is promising (Parr et al., 2006). Connections must be made in education between the acquisition of knowledge and its practical application in the "real world" (Parr et al., 2009). Regardless, for effective construction to occur, learning must be meaningful and relevant to students (Caine & Caine, 1989).

Brain-based learning involves twelve guiding principles that speak to the neurological tenets of the theory. First is that the brain is a parallel processor, capable of performing functions and activities simultaneously, making the most of learning (Figure 2). Educators should take advantage of the academic possibilities of brain-based learning and develop lessons and curriculum suitable for this modality of learning (Caine & Caine, 1995). This can be a weighty task since a frame of reference is an important part of the process of curriculum development suitable for this theory, especially because more than one modality of learning is potentially suitable for the different learning capabilities of the brain (1995) (Figure 2).

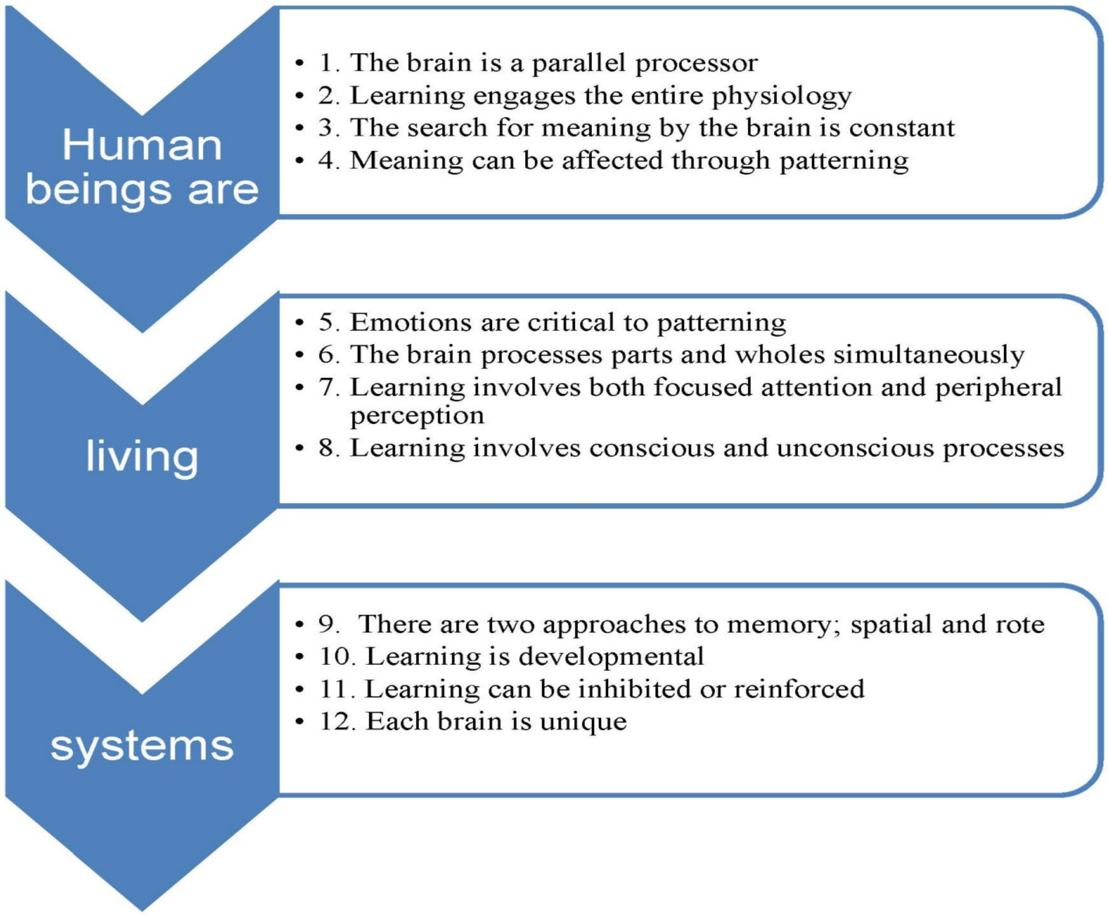


*Figure 2.* Tenets of brain-based learning. (Adapted from Caine & Caine, 1990)

Second, "Learning engages the entire physiology" (Caine & Caine, 1990, p. 66). It has been said that learning is no more complicated than breathing and is capable of being encouraged or retarded, depending on the experiences encountered in school and life. As a result, teaching to the brain-based learner needs to incorporate areas such as nutrition, stress management, and other areas that have a direct relationship to learner health (Caine & Caine, 1990). Natural development of the body and brain has a great impact on learning ability.

The third principle as identified by Caine and Caine (1990) is one of searching for meaning. The brain constantly seeks to make sense of its natural surroundings. This is an occurrence that is classified as being "survival-oriented" and does not require a large amount of metabolic resources from the learner. Accordingly, the brain is searching constantly for stimuli that are fresh and unique to the learner surroundings. This reinforces the posits of Caine and Caine (1990) that people are "meaning-makers" and learning never stops, it is only harnessed and focused for maximum effect. Familiarity and stability are important for learning to occur, and it is essential that opportunities for engagement at a novel level be incorporated and the learner is challenged in creative ways.

The fourth principle of brain-based learning involves the concept that meaning can be affected through patterning. When the learner is exposed to familiar patterns that are not random, enhanced learning is the result. The brain resists patterns with no relevance or meaning in relation to the intended learning goal. For learning to occur and be retained, the learners must be able to create patterns that make sense to them, not attempt solely to interpret the patterns that are imposed on them in the form of instruction (Caine & Caine, 1990).

The fifth principle of brain-based learning is that, "emotions are critical to patterning" (Caine & Caine, 1990, p. 67). Brain-based learning involves the tying of learning to emotions. Events that have had an emotional impact on a person will remain in his/her memories forever. Events such as the destruction of the World Trade Center and the bomb attack on the Alfred P. Murrah Federal building are not likely to be forgotten by those who lived during the occurrence of those events because of the emotions they instilled. It is important for teachers to understand that student learning will be connected directly to the feelings and attitudes they possess and will have a significant impact on future learning (Caine & Caine, 1990). Those student-teacher encounters that occur during the course of the learning experience need to offer support in a sincere way on behalf of both the teacher and the student to be effective and permanent.

The sixth principle of brain-based learning theory involves the concept that the brain perceives and creates parts and wholes simultaneously (Caine & Caine, 1990). The authors posited that most individuals are either left brained or right brained according to their talent and learning capability. Those individuals who are classified as left-brained process knowledge in a sequential and logical manner, whereas right-brained learners learn best in an environment that is not limited by excessive structure. Kornhauser (2008) noted that routines which are not flexible can be boring and stifling to the learning process. However, Caine and Caine (1990) hypothesized that the brain is in fact interactive between each hemisphere and works conjunctively regardless of the subject matter that is being learned. "The value of the 'two-brain' doctrine is that it requires educators to acknowledge the brain's separate but simultaneous tendencies for organizing information" (Caine & Caine, 1990, p. 67). From an educational standpoint, this is an indicator that educators must design and present curriculum that is holistic in nature for good teaching and learning to occur.

The seventh tenet of brain-based learning theory recounts that, "learning involves both focused attention and peripheral perception" (Caine & Caine, 1990, p. 67). Teaching and communication is a sensory context that the brain responds to entirely, that is, information directly perceived, as well as, peripheral information detected by the computer (O'Keefe & Nadel, 1979). Because of this, all of the sensory input that is found in a person's surroundings can have either a positive or negative effect on his/her educational experiences and should be considered when instruction occurs (Caine & Caine, 1990). Moreover, the external stimuli to which the learner is exposed can and should be organized to facilitate learning positively.

Principle eight involves both the conscious and unconscious processes of learning (Caine & Caine, 1990). Teachers normally identify and prepare learning to engage the brain processes intentionally in a positive way. Research indicates that "most of the signals that we peripherally perceive enter the brain without our awareness and interact at unconscious levels" (Caine & Caine, 1990, p. 68). Because of this, it was opined by Caine and Caine (1990) that much of learning, and the effort involved in its development, may be wasted because of the learners' inadequate processing of their experiences. Personal learning styles should be considered by the teacher in the development of instruction and be adaptable to the different learning style modalities of the student. Additionally, effort should be undertaken to provide learning that can be reorganized in a way which is best or preferable for the student (Caine & Caine, 1990).

People learn by using two different types of memory – spatial and rote (Caine & Caine, 1990). Spatial learning is readily accessible for retention of learning and "instant" memorization of experiences that the student has. Information that is available to the learner in bits and pieces that are not related must be obtained and stored through rote memorization to be retained and eventually transferred to spatial memory (Caine & Caine, 1990). Preparation of educational experiences for the learner needs to incorporate aspects of their personal experiences to facilitate the transfer of learning more effectively. This concept leads to the tenth principle of Caine's and Caine's (1990) brain-based learning theory.

The embedding of information into natural spatial memory allows for a more effective understanding of the facts and skills that are a part of the learning process (Caine & Caine, 1990). This concept, in effect, enhances learning and may be the most important tenet of brain-based learning. Examples teachers can use that are obtained from real-life situations are more valuable to the learner than ordinary instruction, which maybe more abstract or "unconnected." The incorporation of scientific and mathematical concepts can be understood better when the learner is exposed to a variety of experiences that contrast with and support the lectures and analysis of subjects conveyed through more traditional or usual teaching processes (Caine & Caine, 1990).

Additionally, learning can be either inhibited or reinforced depending on whether a supportive or threatened environment exists for the learner (Caine & Caine, 1990). Optimal facilitation of learning is experienced when the student is challenged properly. However, when the student feels threatened or is pressured as result of his/her educational experience, the brain has a natural tendency to "down-shift," and learning is retarded (1990). For instruction to be effective, the instructor must provide content in an environment that challenges the learner cognitively, yet is not perceived as intimidating by the student (Caine & Caine, 1990).

Finally, it should be remembered that each brain is unique. Learners are equipped with identical systems that encompass the brain. However, the integration of both left and right hemispheres as well as the "wiring of the processes" is different depending on the individual learner. Different modalities of learning should be considered during the design of curriculum and learning experiences in order to take advantage and support the development of valuable, permanent learning (Caine & Caine, 1990).

Through analysis of these tenets of brain-based learning, it is evident that the primary goal should be that educators as well as learners move away from the concept of memorization and embrace “meaningful” learning (Caine & Caine, 1990). The three interactive elements of brain-based learning, including the concepts of relaxed alertness, immersion, and active processing are essential for learning to occur (Caine & Caine, 1989). Accordingly, “designed overlap” among curricular areas in education should be the goal. Meaningful integration of science concepts as well as mathematical curriculums along with history and reading hold the potential to creating communities of practice essential to enhanced learning (Caine & Caine, 1990).

To incorporate the learning styles of those students who learn best according to the framework of brain-based learning, a major shift in the way teachers educate, develop formative and summative assessments, and organize classrooms for students should be considered to provide a stable but generative learning experience for students (Caine & Caine, 1990).

It is not readily identifiable as to how this process is effective (Chipongian, 2007), but the connection of real-life examples such as in the context of agricultural education could provide meaning to the student, which clarifies and supports his/her learning (Newcomb, McCracken, Warmbrod, & Whittington, 2004). According to Balschweid, Thompson, and Cole (2000), “the integration of science into the agriculture curricula is a more effective way to teach science” (p. 37). Moreover, taking advantage of similar points of connection of scientific principles in agricultural education subject matter would appear to reinforce the underpinnings of brain-based learning theory.

The conceptual/theoretical framework for this section is identified as a combination of the constructivism and brain-based learning theories. The constructivism theory relates that the brain must make connections between knowledge acquisition and practical application in such a way that learning becomes promising (Parr et al., 2006). The effective construction of information, combined with the guiding tenets of brain-based learning, can only occur if learning is meaningful and relevant to the learner (Caine & Caine, 1989). With regard to these theories, in order for curricular integration to have a positive effect on student learning, the brain must be engaged and students must be able to transfer knowledge from one setting to another.

## Summary

This study seeks to determine if a science-enhanced curriculum (i.e., CAERT) delivered in a secondary level animal science or horticulture course will significantly improve students' understanding of selected scientific principles when compared to students who were instructed using a traditional animal science or horticulture curriculum. The curriculum that was used is a web-based curriculum designed to engage students through PowerPoint® presentations of the lessons correlated to E-Units, which are passages of texts designed to reinforce the curricular presentation. The lessons are aligned with current course benchmarks and Priority Academic Student Skills (PASS) standards specific to Oklahoma.

The review of literature in this research identified the importance of a contextually-based learning environment as is provided in various agricultural education programs. This type of hands-on experience is suited for a science-enhanced agricultural curriculum ideally. By providing a blending of an agricultural curriculum with scientific principles, students benefit by experiencing the relationship between the two subject areas firsthand. The report, *Understanding Agriculture: New Directions for Education (1988)*, stated that, “teachers should be encouraged to modify lesson plans to incorporate materials about scientific, economic, and public health aspects of agriculture and related topics in accordance with school policy” (NRC, 1988, p. 11). In order to obtain a better understanding of science concepts needed by students, the instruction of science inside an agricultural curriculum will convey those science principles inside the context of agriculture more effectively (NRC, 1988). Those students who may otherwise become disinterested in the learning of science through a traditional means (Balschweid, 2002) may benefit from the scientific principles that they learn through agricultural education as a result of the integration of the classroom and laboratory contextual experience.

# CHAPTER III

# METHODOLOGY

## Introduction

The purpose of this study was to determine if a science-enhanced curriculum (i.e., CAERT) taught in a secondary level animal science or horticulture course would significantly improve students' understanding of selected scientific principles when compared to students who were instructed using a traditional curriculum. A secondary purpose was to determine the effect that the science-enhanced CAERT curriculum would have on students' agricultural knowledge when compared to students who were instructed using a traditional curriculum.

The following research questions guided this study.

## Research Questions

1. What were the personal characteristics (i.e., gender, age, grade classification, Biology I End of Instruction score, race/ethnicity and number of agricultural education courses taken) of students enrolled in selected animal science or horticulture courses in Oklahoma during spring semester 2010?

2. What were the personal characteristics (i.e., age, gender, race/ethnicity, years of teaching experience, certification areas and highest degree held) of instructors who taught selected animal science or horticulture courses in Oklahoma during the spring semester 2010?
3. What was the effect of a science-enhanced curriculum (produced by the Center for Agricultural and Environmental Research and Training [CAERT]) on students' science achievement, as determined by a science proficiency examination?
4. What effect did the science-enhanced CAERT curriculum, designed for animal science or horticulture courses have on students' agricultural technical skill competence, as determined by state competency examinations for animal science and horticulture?
5. What were selected perceptions of instructors who used the science-enhanced CAERT curriculum to teach selected animal science or horticulture courses during spring semester 2010?

## Null Hypotheses

$H_o1$: The science achievement of students who received the science-enhanced CAERT curriculum in animal science or horticulture will not differ significantly (i.e., $p < .05$) from those students who were taught the traditional animal science or horticulture curriculum, as measured by the TerraNova[3] science achievement examination ($H_o$: $\mu_{1\text{treatment group}} = \mu_{2\text{comparison group}}$).

$H_o2$: The agricultural technical competence of students who received the science-enhanced CAERT curriculum in animal science or horticulture will not differ significantly (i.e., $p < .05$) from those students who received a traditional animal science or horticulture curriculum, as measured by a technical competency test in animal science or horticulture ($H_o$: $\mu_{1\ \text{treatment group}} = \mu_{2\ \text{comparison group}}$).

The assumption was made that students who were engaged in the contextualized, science-enhanced CAERT curriculum (i.e., animal science and horticulture) would be exposed to science concepts and principles at a higher level than students who were instructed in the same courses using a traditional curriculum.  It was also assumed that the students' technical competency in agriculture, per animal science and horticulture courses, would remain at the same level in both the treatment and the comparison groups. Further, it was assumed that both groups (treatment and comparison) were equivalent regarding science achievement.  To determine equivalency, student performance was compared on the Oklahoma Department of Education's End of Instruction (EOI) examination in science.

Student science achievement was measured through a science examination provided by the National Research Center for Career and Technical Education (NRCCTE).  The Oklahoma Department of Career and Technology Education's online Agricultural Education competency-testing program was used to measure students' technical competency in the areas of animal science or horticulture.

## Institutional Review Board

Federal regulations require that the university's research compliance board approve any research conducted which involves human subjects. To meet those requirements, the researcher submitted a complete Institutional Review Board (IRB) application to the Oklahoma State University's Office of University Research and IRB complete with all of the documentation required for review of the research proposal for compliance. It was determined that all of the requirements for the safe and humane treatment of human subjects were met, and approval was granted for the study (Appendix G).

## Population

The population for this study consisted of students whose secondary agricultural education instructors held a science credential in Oklahoma during the 2008-2009 school year. The purposeful sample consisted of 10 treatment group students whose teachers were selected by Agricultural Education Division staff of the ODCTE to use the science-enhanced CAERT curriculum developed for the instruction of animal science and horticulture courses during the 2009-2010 school year. In addition, students of 10 different instructors formed a purposeful comparison group. These teachers also held a science credential and were selected according to specific demographic data obtained from the 2008-2009 Computerized Enrollment System for Instructors (CESI) report. The CESI report is used by the ODCTE, Information Management Division to collect selected characteristics information of Oklahoma secondary agricultural education programs and their students. Therefore, schools that "matched" the treatment group based on review of established criteria were selected to provide an appropriate counterfactual group for the comparison of results.

The criteria used in this study were established and recommended by the National Research Center for Career and Technical Education (NRCCTE), who also provided partial funding for the study. The criteria considered for selection of the counterfactual group included the following. Agricultural education instructors that held an instruction al certification in science at the time of the study, as well as academic performance index (API) scores and socioeconomic status (SES). As such, all students (*N* = 179), whose 20 teachers were selected to participate in the study, were administered agricultural competency examinations. However, random sampling was used to test students' science competence. The instructors' classrooms served as the study's "units of analysis" for purposes of comparison.

## Design of the Study

The design of the study was *ex post facto*, causal comparative because no random assignment of the treatment group occurred (Ary, Jacobs & Razavieh, 2002). The treatment group was "pre-determined" through selection of instructors by ODCTE staff, i.e., agricultural education teachers who received access to the CAERT curriculum. The curriculum was designed to explicate and reinforce scientific principles through the instruction of select agricultural education courses, including modules supported by downloadable lesson plans, aligned learning standards, summary reports, PowerPoint® files, and E-Units (K. Murray, personal communication, October 1, 2009). E-Units are online student text resources that are designed to reinforce the lesson plans that are a part of the CAERT science-enhanced curriculum (D. Pentony, personal communication, December 6, 2010).

The CAERT curriculum was selected for use because it was developed according to standards for agricultural education in Oklahoma, was acceptable for science credit for college entrance purposes, and consisted of an online delivery method. As a result of the state alignment, the animal science curriculum included 28 units with 160 instructional lessons, and the horticulture curriculum included 29 units with 148 lessons (CAERT, 2010). The unique purpose of CAERT is that it is a science-enhanced curriculum not otherwise offered by curriculum providers for use in Oklahoma (K. Murray, personal communication, October 1, 2009).

## Measures of Student Achievement

To determine the effect that a science-enhanced curriculum (produced by the Center for Agricultural and Environmental Research and Training [CAERT]) had on students' science achievement, a science proficiency examination was used. The TerraNova[3] Form G assessment series examination, designed and developed by CTB/McGraw-Hill, (a subsidiary of The McGraw-Hill Companies, Inc) was the examination used in this study.

The examination consists of normed sections that are designed to test student competencies in reading, language, mathematics, social studies, and science (Norms Book, 2008). "A normed section is a subset of *TerraNova Third Edition* for which scores from a nationally representative norm group are available" (Norms Book, 2008, p. 1). The normed section for science consists of 40 multiple choice questions designed to assess student competencies in science. Students were provided with four multiple choice answers for each question in order to determine the correct answer.

To measure the effect that the science-enhanced CAERT curriculum had on students' agricultural knowledge, the ODCTE's online agricultural education competency-testing program was used. Students in Oklahoma have the opportunity to complete a competency examination in their particular CTE curriculum area (ODCTE, 2010d). Those who complete the examination with a score of 70% or better (i.e., proficient) receive a competency certificate and are recognized on stage at the Oklahoma FFA Convention. Specifically, the agricultural competency examination is designed to serve as a guide for the improvement of instruction of the curriculum by the instructor, and to identify student mastery of competencies and skill objectives needed for employment in industry. As such, this examination could serve as a potential form of accountability for course credit (2010d). To achieve this study's purpose, competency examinations in the areas of animal science and horticulture were used. Because the agricultural competency tests are online and not cost prohibitive, teachers were encouraged to test all students in the study ($N$ = 500) in their respective course (i.e., animal science or horticulture).

School district testing liaisons arranged for and proctored the examinations. The agricultural competency examinations are aligned with Oklahoma skill standards that address a wide range of precise areas specific to curriculum in agricultural education. Business and industry representatives in Oklahoma coupled with agricultural educators and university faculty evaluate the skills, knowledge, and competencies needed for the determination of successful proficiency of the agricultural subject matter, and develop questions accordingly. These competency examinations were conducted at the end of the 2010 spring semester (~ late April). The examination scores needed to determine the level of students' agricultural technical competency were obtained through the ODCTE's assessment specialist who facilitates the examination procedure.

## Treatment

The treatment tested in this study was a pre-packaged curriculum offered by Center for Agricultural and Environmental Research and Training (CAERT), Inc. for the instruction of animal science and horticulture in Oklahoma. The curriculum was designed to explicate and reinforce scientific principles through the instruction of select agricultural education courses, including modules supported by downloadable lesson plans, aligned learning standards, summary reports, PowerPoint® files, and E-Units (K. Murray, personal communication, October 1, 2009). The treatment group teachers were provided access to the CAERT curriculum via passwords and user names in summer 2009. These teachers were instructed by ODCTE state staff members to become familiar with the modules pertaining to animal science and horticulture prior to the beginning of the fall semester. Additionally, this group of teachers was brought onto the ODCTE campus for a one-half day training seminar during September 2009 for an overview of the curriculum (i.e., the functions of the curriculum and how to use its teaching resources).

For the purpose of testing this study's intervention (i.e., CAERT curriculum), a purposeful comparison group was selected from the same list of agricultural education teachers who had achieved science certification in Oklahoma ($N = 40$). This group was instructed to teach their courses (i.e., animal science or horticulture) as they always had in the past.

The assumption was made that students' technical competency in agriculture, per animal science or horticulture courses, would remain at the same level in both the treatment and comparison groups after the treatment was administered. Further, it was assumed that both of these groups (treatment and comparison) were equivalent. To determine equivalency of the treatment and comparison groups, student performance was compared on the Oklahoma Department of Education's End of Instruction (EOI) examination in science. In addition, school district's academic performance index and accountability data (API), and the schools' percentage of low income clientele served by the free and reduced lunch program (SES) were compared.

The Oklahoma Department of Education's EOI examination in science is a part of a larger statewide testing program known as the Oklahoma School Testing Program (OSTP) (Oklahoma State Department of Education, 2010a). Students completing an area of instruction are expected to pass the corresponding standardized assessment. EOI examinations are designed to assess a students' level of competency relative to the Priority Academic Student Skills (PASS), which are Oklahoma-based content standards (Oklahoma State Department of Education, 2010b).

Evaluation of student competency level in Biology involved the use of core curriculum test scores for Biology in Oklahoma. These core curriculum tests for students in the state are categorized in accordance with student ability level as established by local school administration and admission, review, and dismissal (ARD) meetings. The two types of core curriculum tests utilized in relation to science are known as the Biology I

End of Instruction test(s), which are administered to the general school population, and the Oklahoma Modified Alternate Assessment Program (OMAAP), which are administered to those students qualifying as a result of local administration ARD meetings.

Four performance levels exist to classify student achievement and are as follows. For the regular test administration (i.e., EOI), performance levels are divided into “advanced” (755 – 999), “satisfactory” (691 – 774), “limited knowledge” (627 – 690), and “unsatisfactory” (440 – 626). The alternate test administration (OMAAP) is divided into four performance levels. They consist of “advanced” (265 – 350), “satisfactory” (250 – 264), “limited knowledge” (233 – 249), and “unsatisfactory” (100 – 232) (Oklahoma State Department of Education, 2010). EOI categorical scores were coded as 1 = “unsatisfactory”, 2 = “limited knowledge”, 3 = “satisfactory”, and 4 = “advanced” for comparison purposes between the regular and alternate test administrations.

The Academic Performance Index (API) for Oklahoma was developed based on the need to compare school performance to meet requirements established by Oklahoma law, as well as legislation pursuant to Public Law 107-110, commonly referred to as No Child Left Behind (Oklahoma State Department of Education, 2010c). API scores range from 0 to 1500, with the most recent reported state average being 1279 (2010c). Components of a school’s API include EOI scores, Academic Excellence as measured by students’ participation on the ACT college entrance examination, remediation rates for college students in reading and mathematics, and school completion, as determined by student attendance coupled with graduation and dropout rates (2010c). To ensure equivalency of the treatment and comparison groups, schools were compared on the basis of EOI scores, API, and socioeconomic status (SES).

When comparing these variables for equivalency, the treatment group had an EOI group mean score of 2.67 (*SD* = 1.12). The mean score for the comparison group was 2.88 (*SD* = .93). The treatment group had an API group mean score of 1387.00 (*SD* = 57.42); the mean score for the comparison group was 1295.86 (*SD* = 74.40). The treatment group had a SES group mean score of 44.85 (*SD* = 13.94). The comparison group had a mean score of 43.53 (*SD* = 9.40) for SES (Table 1).

An independent samples *t*-test was used to compare the treatment and comparison group participants on the EOI, API, and SES variables. However, it was revealed that a statistically significant difference in API scores existed between the two groups ($p$ = .045) at an *a priori* alpha level of .05. Therefore, the reader is cautioned on making generalizations beyond the sample examined in the study.

Table 1

*Treatment and Comparison Group Equivalency According to EOI, API, and Socio-Economic Status*

| Groups | Min. & Max. | *M* | *SD* | *t*-value | *p*-value |
|---|---|---|---|---|---|
| EOI[a] | 1 - 4 | 2.67 | 1.12 | -.561 | .579 |
| EOI[b] | | 2.88 | .93 | | |
| API[a] | 0 - 1500 | 1387.00 | 57.42 | 2.290 | .045* |
| API[b] | | 1295.86 | 74.40 | | |
| SES[a] | 0 - 100% | 44.85 | 13.94 | .197 | .848 |
| SES[b] | | 43.53 | 9.40 | | |

[a] = Treatment
[b] = Comparison
*$p < .05$

The EOI examination also served as the “pre-test” for the establishment of equivalence of groups. The study’s intervention continued throughout the 2009-2010 academic school year. The student performance measure consisted of the TerraNova[3] science achievement examination provided by the NRCCTE. The agricultural education subject area competency tests were administered at the end of the spring 2010 semester to determine the effects of the CAERT curriculum on student achievement in agriculture regarding animal science or horticulture, as appropriate per the course for which students were enrolled.

The NRCCTE agreed to provide science examinations and their scoring for 80 students in the study (i.e., four to five students per classroom). As such, 80 students were selected randomly to ensure a strong power analysis and effect size for the study (J. Stone, personal communication, December 3, 2009). Power is typically determined by sample size (Keppel, 1991) and is defined as, “the probability of correctly rejecting a false null hypothesis” (Shavelson, 1996, p. 314). Therefore, one means to increase power is to increase sample size. As power increases, so does the magnitude of the effect, or effect size (Shavelson). “Effect size is the discrepancy between the null hypothesis and the alternative hypothesis of interest” (Shavelson, 1996, p. 317).

An online calculator was used to estimate the appropriate sample size needed for this study (Soper, 2010). It was found while using three covariates for prediction, that 76 participants were needed to accommodate an alpha level of .05, with an anticipated effect size of .15, and a desired power level of .80. For practical testing purposes, 80 treatment and comparison students were randomly chosen from the 20 classrooms involved in the study to participate in taking the science examination. This allowed the researcher to randomly select four to five students per classroom to achieve the appropriate sample size for the study.

## Fidelity of the Treatment

Measures were instituted to ensure a reliable assessment of fidelity for the study. During the research period (i.e., spring 2010 semester), both treatment and comparison group instructors were requested to complete a weekly measure of fidelity through an online weekly report (Appendix D) protocol. Specifically, teachers were asked to identify the courses, units of instruction, instructional topics, types of curriculum sources, and types of instructional techniques used to teach the curriculum. Reminder e-mails were automatically sent to teachers each Monday as a means for collecting these data. The instrument recommended by NRCCTE, was adopted from previous research (Parr, 2004), which collected similar fidelity of treatment information.

## Data Analysis

In the development stage of this research study, research questions were identified to guide the direction of the study. Per the development of these research questions, it was determined that characteristics of the teachers and those students who were involved in the study were essential to analysis of the data obtained from the posttest administration. To summarize trends and tendencies relating to the personal characteristics data, descriptive statistics, i.e. mean, median, mode, frequency, and percentages, were utilized to analyze selected teacher and student personal and educational characteristics. To achieve research objectives one and two descriptive statistics were employed to analyze selected characteristics and were summarized and calculated according to the results obtained. Creswell (2008) identified that descriptive statistics help to provide an insight on research data through understanding how much variance may exist in collected data and allowing for some insight into how data compares with other groups.

Teachers selected for the study were asked to identify characteristics related to gender, age, teaching experience, race/ethnicity, educational degree held, specialization, and whether or not they held a traditional or alternative teacher certification. Students selected for the study were asked to identify characteristics pertaining to gender, age, grade classification, race/ethnicity, EOI score, and the number of agricultural education classes for which they had been or were enrolled.

Research question three sought to determine the effect that a science-enhanced curriculum produced by CAERT would have on students' science achievement, as determined by a TerraNova[3] science proficiency examination. Additionally, research question five sought to determine if a relationship existed between agricultural competencies demonstrated at the end of instruction and the treatment. Both research questions were satisfied as follows. A comparison of the means (*t*–test) was used to determine the relationship. Specifically, the following formula was employed to analyze these data in this study.

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{{s_1}^2}{n_1} - \frac{{s_2}^2}{n_2}}}$$

To assess both research questions three and four, an independent samples *t*-test was used. Ary, Jacobs, and Razavieh (2002) identified that a *t*-test for independent samples serves as an ideal statistical procedure for determining statistically significant differences between groups. The use of *t*-test statistics to compare means was outlined according to Popham and Sirotnik (1973). They stated that, "The *t*-test is used to determine just how great the difference between two means must be for it to be judged significant, that is, a significant departure from differences, which might be expected by chance alone" (p. 124).

To determine practical significance of the findings, effect size was calculated according to Cohen's *d* to determine to what extent the treatment may possibly have had an effect, if any, on the post-treatment measures of the study (i.e., the TerraNova 3 science-enhanced examination and agricultural competency examinations). The effect size was calculated according to Cohen (1988), i.e., effect size is calculated and compared to three benchmark standards, including a "small" effect size ($d = .20$), a "medium" effect size ($d = .50$), and a "large" effect size ($d = .80$).

Research by Thompson (2002) indicated that adherence to this standard may be too stringent and that the effect itself is determined by what has been studied. For example, large effect sizes can be considered trivial when applied to outcomes that are trivial (Trusty, Thompson, & Petrocelli, 2004). In regard to this proposition, the benchmark standards as identified by Cohen to interpret effect size for this study (as calculated by Cohen's formula) were expanded and compared to the following standard proffered by Thalheimer and Cook (2002) (Table 2).

Table 2

*Relative Size of Cohen's d According to Thalheimer and Cook (2002)*

| Effect Size Classification | Relative Size |
|---|---|
| Negligible Effect | > = - 0.15 and < .15 |
| Small Effect | > = .15 and < .40 |
| Medium Effect | > = .40 and < .75 |
| Large Effect | > = .75 and < 1.10 |
| Very Large Effect | > = 1.10 and < 1.45 |
| Huge Effect | > 1.45 |

Using Thalheimer and Cook (2002), the relative size of a "negligible" effect must be greater than or equal to – 0.15 and less than .15. To be classified as having had a "small" effect, the relative size must be greater than or equal to .15 but below .40. A "medium" effect classification must be greater than or equal to .40 but less than .75 in relative size. Those effect sizes that are considered to be "large" must have a relative size of greater than or equal to .75 but less than 1.10. To have an effect size classified as "very large," the relative size must be greater than or equal to 1.10 but less than 1.45. Finally, in order to have an effect size considered to be "huge," the relative size must be greater than 1.45. For statistical analysis of research questions one through five, *Predictive Analytics SoftWare (PASW) 18.0* and *Microsoft Excel 2007* were used.

Research question five sought to determine the perceptions of those instructors involved in the treatment group to better evaluate their perceived value of the CAERT curriculum. As such, the instructors were asked to provide responses to twelve open-ended questions (Appendix E) designed to determine their opinion on the value, advantages, and disadvantages of the curriculum. Additionally, they were queried regarding their perception of the level of rigor the curriculum held and how engaged the students were during instruction. The responses to this qualitative question were analyzed according to themes to provide triangulation of the data. Themes were identified as a result of an in-depth analysis of the line-by-line data in relation to key statements and recurring words or narrative phrases (Patton, 2002). According to Guba and Lincoln (1994), "human behavior, unlike that of physical objects, cannot be understood without reference to the meanings and purposes attached by human actors to their activities. Qualitative data, it is asserted, can provide rich insight into human behavior" (p. 106).

# CHAPTER IV

## FINDINGS

### Introduction

The purpose of this study was to determine if a science-enhanced curriculum (i.e., CAERT) taught in a secondary level animal science or horticulture course would significantly improve students' understanding of selected scientific principles, when compared to students who were instructed using a traditional curriculum. A secondary purpose was to determine the effect that the science-enhanced CAERT curriculum would have on students' agricultural knowledge when compared to students who were instructed using a traditional curriculum. The following research questions guided this study.

### Research Questions

1. What were the personal characteristics (i.e., gender, age, grade classification, Biology I End of Instruction score, race/ethnicity and number of agricultural education courses taken) of students enrolled in selected animal science or horticulture courses in Oklahoma during spring semester 2010?
2. What were the personal characteristics (i.e., age, gender, race/ethnicity, years of teaching experience, certification areas and highest degree held) of instructors

who taught selected animal science or horticulture courses in Oklahoma during the spring semester 2010?

3. What was the effect of a science-enhanced curriculum (produced by the Center for Agricultural and Environmental Research and Training [CAERT]) on students' science achievement, as determined by a science proficiency examination?
4. What effect did the science-enhanced CAERT curriculum, designed for animal science or horticulture courses, have on students' agricultural technical skill competence, as determined by state competency examinations for animal science and horticulture?
5. What were selected perceptions of instructors who used the science-enhanced CAERT curriculum to teach selected animal science or horticulture courses during spring semester 2010?

## Null Hypotheses

$H_o1$: The science achievement of students who received the science-enhanced CAERT curriculum in animal science or horticulture will not differ significantly (i.e., $p < .05$) from those students who were taught the traditional animal science or horticulture curriculum, as measured by the TerraNova[3] science achievement examination ($H_o$: $\mu_{1\text{treatment group}} = \mu_{2\text{comparison group}}$).

$H_o2$: The agricultural technical competence of students who received the science-enhanced CAERT curriculum in animal science or horticulture will not differ significantly (i.e., $p < .05$) from those students who received a traditional animal science or horticulture curriculum, as measured by a technical competency test in animal science or horticulture ($H_o$: $\mu_{1 \text{ treatment group}} = \mu_{2 \text{ comparison group}}$).

The above mentioned research questions and null hypotheses serve as the basis for presenting the findings and results derived from this study. Each of the research questions and null hypotheses will be addressed per a dedicated section in this chapter.

## General Description of Study's Participants

Oklahoma agricultural educators and their students from 15 secondary agricultural education programs in the state of Oklahoma served as the subjects for this study and provided the data described in the findings section. Mortality continued throughout the study and affected the final sample size. Mortality is "a potential threat to internal validity in an experiment when individuals drop out during the experiment for any number of reasons" (e.g., time, interest, money, friends, or parents who do not want them to participate) (Creswell, 2008, p. 642). The following population sizes that are found in table 3 reflect the pre-treatment and post-treatment populations for each of the assessment measures utilized in the study (Table 3). The pre-treatment measure which included the end of instruction (EOI) examination had nine reported scores from students representing the treatment group and 25 reported scores from students representing the comparison group. Originally, there were 10 schools participating from each group (Table 3). The post-treatment measures included the TerraNova[3] science examination, with 29 treatment students and 40 comparison students participating (Table 3). Of those who took the agriculture competency examination in animal science, 13 treatment and 44 comparison students participated. Of those participants taking the horticulture competency examination, 47 belonged to the treatment group, while 75 participants represented the comparison group (Table 3).

Table 3

*Pre -Treatment – Post-Treatment Mortality Rate of the Science-Enhanced Curriculum Design Study*

| | Pre- Treatment | | Post-Treatment | |
|---|---|---|---|---|
| | EOI | TerraNova[3] | Animal Science | Horticulture |
| Treatment | | | | |
| Teachers | ($n$ = 10) | ($n$ = 4) | – | – |
| Students | 9 | 29 | 13 | 47 |
| Comparison | | | | |
| Teachers | ($n$ = 10) | ($n$ = 7) | – | – |
| Students | 25 | 40 | 44 | 75 |

## Fidelity of the Treatment

Measures were instituted to ensure a reliable assessment of fidelity for the study. During the research period (i.e., spring 2010 semester), both treatment and comparison group instructors were requested to complete a weekly measure of fidelity through an online weekly report (Appendix D) protocol. Specifically, teachers were asked to identify the courses, units of instruction, instructional topics, types of curriculum sources, and types of instructional techniques used to teach the curriculum.

Of the treatment instructors who responded, two taught animal science, and one taught horticulture.  Three out of four identified that they were teaching in a "traditional" instructional day ranging from 50 to 55 minutes, and one identified that he/she taught on an 85 minute block schedule (Table 4).

Table 4

*Treatment and Control Group Curriculum and Instructional Demographics (n = 14)*

| Treatment | | Course Taught | | Instruction | |
|---|---|---|---|---|---|
| | School | ANSI | HORT | Minutes | Type |
| | Charles Page | | 1 | 55 | Regular |
| | Durant | | | 50 | Regular |
| * | Kingfisher | | | | |
| | Lexington | 1 | | 85 | Block |
| * | Mooreland | | | | |
| | Mustang | 1 | | 55 | Regular |
| Control | | | | | |
| | Cushing | | 1 | 45 | Regular |
| * | Comanche | | | | |
| | Edmond | 1 | 1 | 45 | Regular |
| | Fletcher | | 1 | 50 | Regular |
| | Harrah | 1 | 1 | 85 | Block |
| | Jay | 1 | | 45 | Regular |
| * | McLoud | | | | |
| | Waukomis | 1 | 1 | 45 | Regular |

* *No Weekly Report Submission*

Of the comparison instructors who responded, four taught animal science, and five taught horticulture (Table 4).  Five out of six identified that they were teaching in a "traditional" instructional day ranging from 45 to 50 minutes, and one identifying he/she taught on an 85 minute block schedule (Table 4).

The instructors participating in the study were asked what types of instructional planning resources they used during the preparation of their instruction. The treatment group instructors who responded identified three instances of using the CAERT lesson plans (Table 5).

Table 5

*Treatment Group Instructional Planning Resources* (*n* = 6)

| School | Charles Page | Durant | Kingfisher | Lexington | Mooreland | Mustang |
|---|---|---|---|---|---|---|
| CAERT Lesson Plans | 2 | | | 1 | | |
| CAERT Print/Electronic teacher resources | | | | 1 | | |
| CAERT PowerPoint® Files | | | | 1 | | |
| CAERT Instructional E-Units | 2 | | | 3 | | |
| CAERT Course Benchmark aligned questions | | | | 1 | | |
| CIMC Lesson Plans | | | | | | |
| CIMC Print/Electronic teacher resources | | | | | | |
| CIMC PowerPoint® files | | | | | | |
| CIMC Video resources | | | | | | |
| CIMC aligned question resources | | | | | | |
| CEV Lesson Plans | | | | | | |
| CEV Print/Electronic teacher resources | | | | | | |
| CEV PowerPoint® files | | | | | | |
| CEV Video resources | | | | | | |
| CEV aligned question resources | | | | | | |
| Thompson Delmar Publishing | | | | | | |
| Interstate Publishers | | | | | | |
| Pearson Prentice Hall | | | | | | |
| Other | 2 | | | | | 1 |

Only one instructor self-reported use of the CAERT print/electronic teacher resources, as well as the use of the CAERT PowerPoint® files. Five separate instances of use of the instructional E-Units occurred, with one instructor using the CAERT Course Benchmark aligned questions. Additionally, there were three instances of the use of other curriculum resources by those treatment group instructors responding to the fidelity of treatment report (Table 5).

Of those who self-reported their use of instructional planning resources from the comparison group, two identified that they had used the CAERT lesson plans, while one reported the use of the print/electronic teacher resources (Table 6). CAERT PowerPoint® files were used twice by the instructors. CIMC lesson plans were used 15 times, and CIMC PowerPoint® files were accessed three times (Table 6). Finally, CIMC video resources were accessed nine times by the comparison group teachers.

The comparison instructors used CEV lesson plans four separate times (Table 6). One instructor used the Print/Electronic teacher resources associated with the CEV curriculum. Four identified that they used the PowerPoint® files provided by CEV, and eight used the CEV video resources. Two instructors used the CEV aligned question resources as a part of their instructional preparation.

Teachers used the Thompson Delmar Publishing instructional materials 21 times. Four identified they used material from Interstate Publishers, and two identified they used other resources as a part of their instructional preparation (Table 6).

Table 6

*Control Group Instructional Planning Resources* (*n* = 8)

| School | Cushing | Comanche | Edmond | Fletcher | Harrah | Jay | McLoud | Waukomis |
|---|---|---|---|---|---|---|---|---|
| CAERT Lesson Plans | | | 1 | | 1 | | | |
| CAERT Print/Electronic teacher resources | | | | | 1 | | | |
| CAERT PowerPoint® Files | | | | | 2 | | | |
| CAERT Instructional E-Units | | | | | | | | |
| CAERT Course Benchmark aligned questions | | | | | | | | |
| CIMC Lesson Plans | 1 | | 9 | | | 4 | | 1 |
| CIMC Print/Electronic teacher resources | | | | | | | | |
| CIMC PowerPoint® files | | | | | 3 | | | |
| CIMC Video resources | | | 3 | | 6 | | | |
| CIMC aligned question resources | | | | | | | | |
| CEV Lesson Plans | | | 2 | 1 | 1 | | | |
| CEV Print/Electronic teacher resources | | | | | 1 | | | |
| CEV PowerPoint® files | | | 3 | | 1 | | | |
| CEV Video resources | | | 1 | 2 | 5 | | | |
| CEV aligned question resources | | | | 1 | 1 | | | |
| Thompson Delmar Publishing | | | 10 | | 11 | | | |
| Interstate Publishers | | | | | | 3 | | 1 |
| Pearson Prentice Hall | | | | | | | | |
| Other | 1 | | | 1 | | | | |

Treatment group instructors used lecture four times as their preferred teaching method of choice (Table 7). Two used the lecture with discussion method, three used the questioning method, and two used the demonstration method. Additionally, two reported that they used small group discussion /modeling, one used student-led discussion

/activity, four used discussion, and two used hands-on, experiential learning (Table 7).

Table 7

*Treatment Group Instructional Practices* (*n* = 6)

| School | Charles Page | Durant | Kingfisher | Lexington | Mooreland | Mustang |
|---|---|---|---|---|---|---|
| Lecture | 2 | | | 1 | | 1 |
| Lecture with discussion | | | | 2 | | |
| Teacher questioning | 1 | | | 1 | | 1 |
| Teacher demonstration | 2 | | | | | |
| Teacher problem modeling | | | | | | |
| Small group discussion /modeling | 2 | | | | | |
| Student led discussion /activity | 1 | | | | | |
| Class discussion | 2 | | | 1 | | 1 |
| Hands on; experiential activity | 2 | | | | | |
| Independent student work | | | | 2 | | |
| Use of computers, calculators, or other technology | 2 | | | | | |
| Cooperative learning activity | 1 | | | | | |
| Laboratory activity | 1 | | | 1 | | |
| Work sheet work /writing | | | | 1 | | 1 |
| Use of text, reading materials | | | | | | |
| Teacher interaction with individual students | | | | | | |
| Assessment of student learning | | | | | | |
| Review of assignments /tests /projects | | | | | | |
| Assign homework | | | | | | 1 |
| Out of classroom (field exp., shop, greenhouse, etc.) | 2 | | | | | 1 |

Two instructors identified the use of independent student work in their practice; two used computers, calculators, or other technology; with one choosing to use cooperative learning activities (Table 7). Treatment group instructors used laboratory activities two separate times during the reporting period, with two instances of work sheet work/writing. One instructor identified that they had assigned homework, with three instances of out of classroom activities.

Those comparison group instructors who self-reported their use of instructional practices documented the following practices. They identified 23 instances of lecture; 17 lecture with discussion; 16 instances of teacher questioning practices; with 16 documented reports of teacher demonstration and two instances of teacher problem modeling (Table 8). Three reported they used small group discussion /modeling; with two identifying the use of student led discussion /activity; 12 self-reported the use of class discussion; with 10 using hands on; experiential activity (Table 8).

Three instructors identified the use of independent student work in their practice (Table 8). Three used computers, calculators, or other technology, and five used cooperative learning activities. Comparison group instructors used laboratory activities 18 separate times during the reporting period, with 15 instances of worksheet work/writing. Additionally, seven documented their use of text and reading materials as a part of their practice. Twelve documented instances of teacher interaction with individual students. Four instances of some form of assessment of student learning were used by the comparison group, with six choosing to review assignments, tests and projects with their students (Table 8). None of the comparison group instructors identified they had assigned homework, with 20 instances of out of classroom activities (Table 8).

Table 8

*Comparison Group Instructional Practices* (*n* = 8)

| School | Cushing | Comanche | Edmond | Fletcher | Harrah | Jay | McLoud | Waukomis |
|---|---|---|---|---|---|---|---|---|
| Lecture | 2 | | 8 | | 7 | 6 | | |
| Lecture with discussion | 1 | | 2 | 4 | 7 | 2 | | 1 |
| Teacher questioning | 3 | | 6 | 1 | 5 | | | 1 |
| Teacher demonstration | 2 | | 5 | | 4 | 4 | | 1 |
| Teacher problem modeling | | | | | 2 | | | |
| Small group discussion /modeling | 2 | | | | | | | 1 |
| Student led discussion /activity | 1 | | | | 1 | | | |
| Class discussion | 1 | | 3 | 4 | 2 | 1 | | 1 |
| Hands on; experiential activity | 2 | | 3 | 2 | 2 | | | 1 |
| Independent student work | 2 | | 1 | | | | | |
| Use of computers, calculators, or other technology | | | | | 2 | 1 | | |
| Cooperative learning activity | | | 5 | | | | | |
| Laboratory activity | 2 | | 7 | 4 | 4 | | | 1 |
| Work sheet work /writing | 1 | | 2 | 1 | 11 | | | |
| Use of text, reading materials | 2 | | | | 4 | | | 1 |
| Teacher interaction with individual students | 3 | | 2 | 1 | 2 | 4 | | |
| Assessment of student learning | 2 | | 1 | | | | | 1 |
| Review of assignments / tests / projects | 1 | | 4 | | | | | 1 |
| Assign homework | | | | | | | | |
| Out of classroom (field exp., shop, greenhouse, etc.) | 2 | | 5 | | 6 | 6 | | 1 |

## Selected Student Personal and Educational Characteristics

### *Research Question One*

Research question one sought to determine what the personal characteristics (i.e., gender, age, grade classification, end of instruction score (EOI), number of agricultural science courses taken and race/ethnicity) were of students who were enrolled in the targeted Oklahoma animal science or horticulture courses involved in the study ($N$ = 80). The students who were involved in the study were asked for their personal characteristics information in conjunction with their post test administrations (i.e., science examination and agriculture competency examination). A total of 69 students completed the questionnaire (treatment $n$ = 29; comparison $n$ = 40) administered during the post treatment testing process. The personal characteristics data identified as a result of research question one were analyzed using frequencies and percentages (Table 9).

#### *Treatment group student personal characteristics*

The personal characteristics information for treatment group respondents consisted of 13 males (45%) and 16 females (55%) (Table 9). Of the students who were part of the treatment group, it was revealed that none of the students fell in the age classification of 14 years. One respondent was 15 (3%), nine respondents were 16 (31%), six (21%) respondents were 17 and 13 (45%) respondents were 18 years of age or older.

Regarding race/ethnicity of those who responded, 24 respondents (83%) self-selected their classification as White/Caucasian. None of the students reported that they were either African-American or Asian (Table 9). The American Indian/Alaskan Native/Pacific Islander race/ethnicity category consisted of four respondents (14%). One respondent returned the personal characteristics questionnaire identify their race/ethnicity as “other” (3%) (Table 9).

Table 9

*Selected Personal Characteristics of Treatment Group Secondary Agricultural Education Students* ($n$ = 29)

| Variable | | *f* | % |
|---|---|---|---|
| Gender | | | |
| | Male | 13 | 44.8 |
| | Female | 16 | 55.2 |
| Age | | | |
| | 14 | 0 | 0.0 |
| | 15 | 1 | 3.4 |
| | 16 | 9 | 31.0 |
| | 17 | 6 | 20.7 |
| | 18 years or older | 13 | 44.8 |
| Race/Ethnicity | | | |
| | White/Caucasian | 24 | 82.8 |
| | African-American | 0 | 0.0 |
| | Asian | 0 | 0.0 |
| | American Indian/Alaskan Native/Pacific Islander | 4 | 13.8 |
| | Other | 1 | 3.4 |
| Grade Classification | | | |
| | 8th | 0 | 0.0 |
| | 9th | 0 | 0.0 |
| | 10th | 11 | 37.9 |
| | 11th | 4 | 13.8 |
| | 12th | 14 | 48.2 |

In regard to grade level classification, no respondents from the treatment group represented the eighth or ninth grades (Table 9). Eleven of the respondents (38%) were tenth graders, four of the respondents (14%) were eleventh graders, and the final 14 (48%) were twelfth graders.

*Comparison group student personal characteristics*

Personal characteristics of the secondary agricultural education comparison group respondents were analyzed using frequencies and percentages (Table 10). Of the comparison group respondents, 18 (45%) were male and 22 (55%) were female. It was determined that one of the respondents (3%) was 14 years of age, and five of the respondents (13%) were 15 years of age. Fifteen (38%) respondents were 16 years of age. Eleven (28%) were 17 years of age, and eight (20%) were 18 years of age or older (Table 10).

As for race/ethnicity, 34 (85%) students classified themselves as White/Caucasian, five (13%) identified their race/ethnicity as being American Indian/Alaskan Native/Pacific Islander, and one respondent (3%) selected the “other” classification (Table 10). None of the respondents identified that they were African-American or Asian.

In regard to grade classification, it was discovered that none of the students were eighth graders (Table 10). Rather, the students were distributed evenly across the remaining grade classification levels. Specifically, six respondents (15%) represented the ninth grade, 17 of the respondents (43%) were tenth graders, seven (18%) were eleventh graders, and 10 (25%) were twelfth graders (Table 10).

Table 10

*Selected Personal Characteristics of Comparison Group Secondary Agricultural Education Students* ($n$ = 40)

| Variable | | *f* | % |
|---|---|---|---|
| Gender | | | |
| | Male | 18 | 45.0 |
| | Female | 22 | 55.0 |
| Age | | | |
| | 14 | 1 | 2.5 |
| | 15 | 5 | 12.5 |
| | 16 | 15 | 37.5 |
| | 17 | 11 | 27.5 |
| | 18 years or older | 8 | 20.0 |
| Race/Ethnicity | | | |
| | White/Caucasian | 34 | 85.0 |
| | African-American | 0 | 0.0 |
| | Asian | 0 | 0.0 |
| | American Indian/Alaskan Native/Pacific Islander | 5 | 12.5 |
| | Other | 1 | 2.5 |
| Grade Classification | | | |
| | 8th | 0 | 0.0 |
| | 9th | 6 | 15.0 |
| | 10th | 17 | 42.5 |
| | 11th | 7 | 17.5 |
| | 12th | 10 | 25.0 |

## Selected Personal and Educational Characteristics of the Teacher Participants

### *Research Question Two*

Research question two sought to determine the personal characteristics (i.e., age, gender, race/ethnicity, years of teaching experience, certification areas, highest degree held) of instructors ($N$ = 20) who taught the targeted Oklahoma animal science or horticulture courses involved in the study. To answer this question, the use of descriptive statistical analysis techniques was employed. The teachers involved in the study were asked for their personal characteristics information via a questionnaire distributed with their test material packets in late April 2010. A total of 11 teachers completed the questionnaire (treatment, $n$ = 4; comparison, $n$ = 7). The personal characteristics data were analyzed using frequencies and percentages (Tables 11 & 12).

The data describing gender, age, and race/ethnicity for the treatment group instructors who participated in the study were nominal. The gender makeup of the responding group consisted of three males (75%) and one female (25%) (Table 11). Regarding age, no respondents represented the 20 to 29 year old age classification. One respondent (25%) was between 30 and 39 years of age, and three respondents were 50 to 59 years of age.

Table 11

*Gender, Age and Race/Ethnicity of Treatment Group Secondary Agricultural Education Instructors* (*n* = 4)

| Variable | | *f* | % |
|---|---|---|---|
| Gender | | | |
| | Male | 3 | 75.0 |
| | Female | 1 | 25.0 |
| Age | | | |
| | 20 to 29 | 0 | 0.0 |
| | 30 to 39 | 1 | 25.0 |
| | 40 to 49 | 0 | 0.0 |
| | 50 to 59 | 3 | 75.0 |
| | 60 or more years of age | 0 | 0.0 |
| Race/Ethnicity | | | |
| | White/Caucasian | 4 | 100.0 |
| | African-American | 0 | 0.0 |
| | Asian | 0 | 0.0 |
| | American Indian/Alaskan Native/Pacific Islander | 0 | 0.0 |
| | Other | 0 | 0.0 |

Further, these study participants in the treatment group were asked to identify their personal characteristics regarding degree, certification type, and years of teaching experience. When asked about their highest level of education, two of the respondents (50%) held either a Bachelor of Science or Bachelor of Arts degree and two (50%) held a master's degree (Table 12). None of the participants who responded identified that they had some post graduate work or held a doctoral degree.

In regard to certification type, all four of the respondents (100%) indicated that they held a traditional teacher license or certification status instead of an alternative form of certification. When asked about their years of teaching experience, it was revealed that one respondent (25%) had 6 to 10 years of teaching experience. The remaining three respondents (75%) identified that they had 21 years or more of teaching experience (Table 12).

Table 12

*Degree, Certification Status and Teaching Experience of Treatment Group Secondary Agricultural Education Instructors* (*n* = 4)

| Variable | | *f* | % |
|---|---|---|---|
| Educational Level | | | |
| | BS/BA | 2 | 50.0 |
| | Some Post Graduate Work | 0 | 0.0 |
| | Master's | 2 | 50.0 |
| | Doctoral degree – Ph.D./Ed.D. | 0 | 0.0 |
| Certification | | | |
| | Traditional | 4 | 100.0 |
| | Alternative | 0 | 0.0 |
| Teaching Experience | | | |
| | 0 to 5 | 0 | 0.0 |
| | 6 to 10 | 1 | 25.0 |
| | 11 to 15 | 0 | 0.0 |
| | 16 to 20 | 0 | 0.0 |
| | 21 or more years | 3 | 75.0 |

When analyzing the nominal data (i.e., gender, age, and race/ethnicity) for the secondary agricultural education comparison group instructors who participated in the study, it was revealed that six of the respondents (86%) were male and one respondent (14%) was female (Table 13). One respondent (14%) was between 30 and 39 years of age, one respondent belonged to the 40 to 49 years of age classification (14%), four of the respondents (57%) indicated the 50 to 59 years old classification, and one teacher represented the 60 years or older age classification (14%) (Table 13).

Table 13

*Gender, Age, and Race/Ethnicity of Comparison Group Secondary Agricultural Education Instructors* (*n* = 7)

| Variable | | *f* | % |
|---|---|---|---|
| Gender | | | |
| | Male | 6 | 85.7 |
| | Female | 1 | 14.3 |
| Age | | | |
| | 20 to 29 | 0 | 0.0 |
| | 30 to 39 | 1 | 14.3 |
| | 40 to 49 | 1 | 14.3 |
| | 50 to 59 | 4 | 57.1 |
| | 60 or more years of age | 1 | 14.3 |
| Race/Ethnicity | | | |
| | White/Caucasian | 6 | 85.7 |
| | African-American | 0 | 0.0 |
| | Asian | 0 | 0.0 |
| | American Indian/Alaskan Native/Pacific Islander | 1 | 14.3 |
| | Other | 0 | 0.0 |

When asked the level of education held, four (57%) of the respondents identified that they held either a Bachelor of Science or Bachelor of Arts degree. One of the respondents (14%) had obtained some level of "post graduate work" and two (29%) of the respondents revealed they held a master's degree (Table 14). In regard to certification type, all seven of the respondents (100%) indicated that they held a traditional teacher license instead of an alternative certification. As for years of teaching experience, one respondent (14%) had between 6 and 10 years experience as an educator, one respondent (14%) had between 16 and 20 years of teaching experience, and the remaining five (71%) who responded to the questionnaire had 21 or more years of teaching experience (Table 14).

Table 14

*Degree, Certification Status, and Teaching Experience of Comparison Group Secondary Agricultural Education Instructors* (*n* = 7)

| Variable | | *f* | % |
|---|---|---|---|
| Educational Level | | | |
| | BS/BA | 4 | 57.1 |
| | Some Post Graduate Work | 1 | 14.3 |
| | Masters | 2 | 28.6 |
| | Doctoral degree – Ph.D. / Ed.D. | 0 | 0.0 |
| Certification | | | |
| | Traditional | 7 | 100.0 |
| | Alternative | 0 | 0.0 |
| Teaching Experience | | | |
| | 0 to 5 | 0 | 0.0 |
| | 6 to 10 | 1 | 14.3 |
| | 11 to 15 | 0 | 0.0 |
| | 16 to 20 | 1 | 14.3 |
| | 21 or more years | 5 | 71.4 |

When the secondary agricultural education teachers were asked to provide information regarding their area(s) of specialization associated with a baccalaureate degree, it was found that, of the treatment group teachers, one identified a specialization in animal science (25%). Two teachers held minors in science and physics, respectively (50%). One respondent (25%) held a certification in physical science, biology, and earth science. Additionally, one of the respondents held physical education (PE) certification (25%) (Table 15).

Table 15

*Self-Reported Degree-Related Specializations of Treatment Group Secondary Agricultural Education Instructors* (*n* = 4)

| Degree-Related Specializations | *f* | % |
|---|---|---|
| Baccalaureate Level Specialization | | |
| Animal Science | 1 | 25.0 |
| Science (Minor) | 1 | 25.0 |
| Physics (Minor) | 1 | 25.0 |
| Science – Physical, Biology, and Earth Certification | 1 | 25.0 |
| Physical Education | 1 | 25.0 |
| Master's Level Specialization | | |
| Elementary Principal | 1 | 25.0 |
| Counseling | 1 | 25.0 |
| Secondary Administration | 2 | 50.0 |
| Science | 1 | 25.0 |

In addition to the certifications that were held by the respondents at the bachelor's degree level, it was also revealed that a number held certifications earned at the graduate level. Specifically, one of the respondents (25%) held an elementary principal certification, one (25%) held a certification in the area of counseling, two revealed that they held a specialization in secondary administration (50%), and one held a master's level science specialization (25.0%) (Table 15).

The comparison group teachers' degree-related specializations were also solicited. Specifically, regarding bachelor of science degree-related specializations, one respondent (14%) held a meats and production certification, one (14%) held an agronomy specialization with an animal science minor, one respondent (14%) held an animal science degree, and one respondent (14%) held a minor in chemistry. One respondent (14%) revealed he/she held a bachelor of arts (BA) in science with a concentration in general, physical, and environmental science, and one respondent held a master's degree in education (14%) (Table 16).

Table 16

*Self-Reported Degree-Related Specializations of Comparison Group Secondary Agricultural Education Instructors* (*n* = 7)

| Degree-Related Specialization | *f* | % |
|---|---|---|
| Baccalaureate Level Specialization | | |
| Meats and Production | 1 | 14.3 |
| Agronomy / Animal Science (Minor) | 1 | 14.3 |
| Animal Science | 1 | 14.3 |
| Chemistry (Minor) | 1 | 14.3 |
| Science – General, Physical, and Environmental | 1 | 14.3 |
| MS Area of Specialization | | |
| Education | 1 | 14.3 |

## Quantitative Science-Enhanced Examination Analysis

*Research Question Three*

Research question number three sought to determine what effect a science-enhanced curriculum produced by the Center for Agricultural and Environmental Research and Training (CAERT) had on students' science achievement, as determined by the TerraNova[3] science proficiency examination. The first null hypothesis developed to guide the study was aligned with research question three:

$H_o1$: The science achievement of students who received the science-enhanced CAERT curriculum in animal science or horticulture will not differ significantly (i.e., $p < .05$) from those students who were taught the traditional animal science or horticulture curriculum, as measured by the TerraNova[3] science achievement examination ($H_o$: $\mu_{1\text{treatment group}} = \mu_{2\text{comparison group}}$).

Student science achievement was assessed through administration of the *TerraNova[3] Third Edition Form G assessment series.* The examination consists of normed sections designed to assess student competency in areas relating to reading, language, mathematics, and science. To address research question three and null hypothesis one, the science portion of the examination was administered after the treatment (i.e., teaching of the CAERT science-enhanced curriculum) to assess and compare the science achievement of the treatment and comparison group students. Data were analyzed and converted to percentages (0 – 100) from raw data (0 – 40) for purposes of analysis using the following formula:

*Science-Enhanced Examination Raw Score/Total Raw Score X 100=% Score*

The treatment group students (*N* = 29) who took the science-enhanced examination had a group mean score of 55.86 with a standard deviation of 16.55 (Table 17). The comparison group mean score (*N* = 40) was 53.31 with a standard deviation of 16.01. An independent samples *t*-test comparison of the treatment and comparison groups did not reveal a statistically significant difference in science achievement as a result of the treatment (*p* = .522) at an *a priori* alpha level of .05. To ensure the equality of variances, Levene's test (*α* = .797) for equality of variances was conducted. Further, the effect size, calculated according to Thalheimer and Cook (2002), resulted in a "small" effect (*d* = .16) (Table 17).

Table 17

*Science-Achievement Examination Scores of Treatment and Comparison Groups*

| TerraNova[3] Examination | Min. & Max. | *f* | *M* | *SD* | *t*-value | *p*-value |
|---|---|---|---|---|---|---|
| Treatment | 0-100 | 29 | 55.86 | 16.55 | .644 | .522[a] |
| Comparison | | 40 | 53.31 | 16.01 | | |

*p* < .05
[a]Effect size = "Small" (.16 per Cohen's *d*; Thalheimer & Cook, 2002)

As such, the null hypothesis ($H_o1$) was accepted, indicating that the science-enhanced CAERT curriculum did not have a statistically significant effect on students' science achievement.

The end of instruction (EOI) examination in Biology I for Oklahoma was used as the "Pre-Test" for comparison purposes in this study. Reported scores for the treatment group's (*N* = 9) EOI examination had a mean score of 2.67 with a standard deviation of 1.12 (Table 18).

Table 18

*End of Instruction Examination Scores of Treatment and Comparison Groups*

| EOI Examination | Min. & Max. | *f* | *M* | *SD* | *t*-value | *p*-value |
|---|---|---|---|---|---|---|
| Treatment | 1-4 | 9 | 2.67 | 1.12 | -.561 | .579 |
| Comparison | | 25 | 2.88 | .93 | | |

$p < .05$

The comparison mean score (*N* = 25) was 2.88 with a standard deviation of .93. An independent samples *t*-test comparison of the treatment and comparison groups did not reveal a statistically significant difference in student science knowledge ($p = .579$) prior to the treatment at an *a priori* alpha level of .05. To ensure the equality of variances, Levene's test ($\alpha = .461$) for equality of variances was conducted.

## Effect of the Science-Enhanced CAERT Curriculum on Students' Agricultural Technical Competence

### *Research Question Four*

Research question number four sought to determine what effect the science-enhanced CAERT curriculum designed for animal science or horticulture courses would have on students' technical skill competence in agriculture, as determined by state competency examinations for animal science and horticulture. The second null hypothesis developed to guide the study was aligned with research question four:

$H_o2$: The agricultural technical competence of students who received the science-enhanced CAERT curriculum in animal science or horticulture will not differ significantly (i.e., $p < .05$) from those students who received a traditional animal science or horticulture curriculum, as measured by a technical competency test in animal science or horticulture ($H_o$: $\mu_{1\text{ treatment group}} = \mu_{2\text{ comparison group}}$).

Students' technical competency in animal science and horticulture was assessed through use of the ODCTE's online agricultural competency examinations in animal science and horticulture. To address null hypothesis two, these respective online examinations were administered to students in both the treatment and comparison groups after the intervention (i.e., teaching of CAERT curriculum) had occurred.

The treatment group ($N = 47$) who took the horticulture competency examination, had a group mean score of 37.47 with a standard deviation of 6.62 (Table 19). The comparison group ($N = 75$) students' mean score was 31.48 with a standard deviation of 6.55.

Those study participants who completed the animal science competency examination yielded the following results: The treatment group students ($N = 13$) had a mean score of 40.85 with a standard deviation of 7.05. The comparison group's mean score for those students ($N = 44$) who took the animal science competency examination was 32.05 with a standard deviation of 7.70 (Table 19).

An independent samples *t*-test comparison of the treatment and comparison groups in horticulture revealed a statistically significant difference in technical competence as a result of the treatment ($p$ = .000) at an *a priori* alpha level of .05 (Table 19).

Table 19

*Agricultural Competency Examination Scores for Horticulture and Animal Science: Treatment and Comparison Groups*

| Competency Examination | Min. & Max. | *f* | *M* | *SD* | *t*-value | *p*-value* |
|---|---|---|---|---|---|---|
| Horticulture | | | | | | |
| Treatment | 0-55 | 47 | 37.47 | 6.62 | 4.89 | .000[a] |
| Comparison | | 75 | 31.48 | 6.55 | | |
| Animal Science | | | | | | |
| Treatment | 0-55 | 13 | 40.85 | 7.05 | 3.69 | .001[b] |
| Comparison | | 44 | 32.05 | 7.70 | | |

*$p$ < .05
[a] Effect size = “Large” (.92 per Cohen’s *d*; Thalheimer & Cook, 2002)
[b]Effect size = “Very Large” (1.18 per Cohen’s *d*; Thalheimer & Cook, 2002)

The treatment group students performed significantly better on the technical competency examination for horticulture. To ensure the equality of variances, Levene’s test ($\alpha$ = .764) for equality of variances was conducted. Further, the effect size, calculated according to Thalheimer and Cook (2002), indicated a “large” effect ($d$ = .92).

Additionally, it was revealed that a statistically significant difference existed in technical competence among the two groups regarding the competency examination in animal science ($p$ = .001). The treatment group students performed significantly better on the technical competency examination for animal science. To ensure the equality of variances, Levene’s test for equality of variances was conducted ($\alpha$ = .506). Effect size for the animal science competency examination was calculated and indicated a "very large" effect ($d$ = 1.18). As a result of the $t$-test comparisons for both the horticulture and animal science courses, it was determined that a positive effect, statistically and practically, existed regarding the agricultural competency of those students who received the treatment. As such, the null hypothesis ($H_o4$) was rejected, indicating that the science-enhanced CAERT curriculum had a positive and statistically significant effect on students' technical competency in horticulture and animal science.

## Qualitative Data Analysis

### *Research Question Six*

Research question five sought to determine the perceptions of the instructors who used the science-enhanced CAERT curriculum to teach animal science or horticulture courses during the study. Responses to the research protocol were submitted electronically via electronic mail. The teachers' responses have been aligned according to themes. The responses to this qualitative question were analyzed according to themes to provide a form of triangulation to support the study's design (Creswell, 2008). Themes were identified as a result of an in-depth evaluation of the line-by-line data in relation to key statements and recurring words (Patton, 2002). Copies of the interview and teacher responses are found in appendices E and F.

#### *Theme: Advantages to the CAERT Curriculum's Design*

Instructors were asked what they preferred about the CAERT curriculum and its advantages. Additionally, they were asked how this particular curriculum design would help them to become a better instructor. Only two teachers responded to these questions. It was agreed that the curriculum offered an advantage to the teacher regarding ease of preparation. Instructor one stated, "I enjoyed that the lessons were prepared ahead of time, and little work was needed to get ready for the lesson. . . I always had something to teach when I walked into the classroom." Instructor two appreciated the format of the curriculum. Instructor two said, "I like that it was online because students seem to think that everything comes from the Internet these days. . . makes it more fun for them." Additionally, instructor two expressed that, "It [online learning] fits their current learning style." Moreover, "I like that since it is electronic information instead of printed, information updates and new technologies can be updated faster so the students are getting the newest and latest information." Instructor one also commented that one of the advantages of the curriculum is it provides "[m]any lessons at an affordable price."

When the instructors were asked to describe the science content in relation to other pre-packaged curriculums that they may have used, instructor two identified that the curriculum was ". . . similar to other curriculum that I have used; the main difference is how it is delivered." Instructor one acknowledged the science content as being deeper and more involved than other curriculums used in the past. He/she stated, the curriculum ". . . would definitely meet many science PASS standards." Moreover, he/she said, "The lessons were complete and contained a wide variety of science-based information."

*Theme: Student Engagement, Learning, Retention, Appropriateness and Effectiveness*

Instructors were queried regarding their students' level of engagement when teaching the CAERT curriculum. The two teachers who responded referred to the difficulty and rigor of the curriculum. Instructor one commented that, ". . . some of the material was way over their heads, and they [students] gave up on understanding it." Instructor two added that, "The students enjoyed using the curriculum except for the powerpoints. Too much information was crammed into each slide . . .," However, when referring to the remainder of the curriculum, instructor two commented that, "[f]or the most part, it challenged my students without presenting concepts that were too difficult for them to grasp." Additionally when questioned about the use of the curriculum in teaching, instructor two indicated that the curriculum was especially useful as a tool to help students identify the parts of the stem. He observed that his students seemed to ". . . like using this [curriculum] as study guides for quizzes and tests." The online aspect of the curriculum "fits their current learning style [and] . . . the textbook style was easy to read and the students liked it." When asked how the CAERT curriculum could be improved, instructor one stated that, ". . . I believe many of the lessons would need to be taught at a lower science level for many students to better understand them."

*Theme: Limitations/Barriers to Students Using the CAERT Curriculum*

Regarding barriers related to using the CAERT curriculum, instructor one commented, ". . . the main barrier is the fact that it is online, and when our school servers are down, it is very frustrating." Instructor two added, "It would be nice if the students had a way to download the curriculum to take home on a laptop. . . Too few of my students have Internet at home for their use." Additionally, instructor two commented, "Many of my students do not have high speed Internet if they have Internet connections at home." Per a follow up comment from instructor two, it was identified that their local school district had passed a bond issue allowing for funds to provide each student at the high school a portable computer for “each student to take home that has their textbooks loaded on them.”

### *Theme: Limitations/Barriers to Instructors Using the CAERT Curriculum*

The instructors were asked what they perceived to be barriers associated with the CAERT curriculum. Instructor one expressed that, “Most of our ag teachers are not technologically savvy and will have problems accessing the correct stuff.” Additionally, this instructor stated that, “. . . if we all had adequate training in a computer facility where we could actually be shown all the extra things on the program, that would help!” Moreover, instructor one was concerned that the online format could be cumbersome potentially for older instructors who might encounter difficulties with the process.

Instructor two identified that his students acknowledged that the curriculum’s PowerPoints® could be improved. “I would have students tell me that they could develop better PowerPoints® than the ones online.” The instructor stated further that it was necessary to offer two to three additional hours of modification for each section that was taught. “That became tiresome so I quit using the PowerPoints®.”

When asked how the curriculum could be improved, instructor two clarified the need for additional instruction in the use of the curriculum. “I could not figure out how to use the test banks. The two times that I tried to use the test banks they were cumbersome and not easy to use [so] I developed my own test.” This apparently was not an isolated incident, for instructor two added, “I did talk to other teachers, and they were having similar problems.”

CHAPTER V

# SUMMARY, CONCLUSIONS, RECOMMENDATIONS, IMPLICATIONS AND DISCUSSION

## Summary

The purpose of this study was to determine if a science-enhanced curriculum (i.e., CAERT) taught in a secondary level animal science or horticulture course would significantly improve students' understanding of selected scientific principles, when compared to students who were instructed using a traditional curriculum. A secondary purpose was to determine the effect that the science-enhanced CAERT curriculum would have on students' agricultural knowledge when compared to students who were instructed using a traditional curriculum.

The assumption was made that students who were engaged in the contextualized, science-enhanced CAERT curriculum (i.e., animal science and horticulture) would be exposed to science concepts and principles at a higher level than students who were instructed in the same courses using a traditional curriculum. It was also assumed that the students' technical competency in agriculture, per animal science and horticulture courses, would remain at the same level in both the treatment and the comparison groups. Further, it was assumed that both groups (treatment and comparison) were equivalent regarding science achievement. The following research questions guided the study.

## Research Questions

1. What were the personal characteristics (i.e., gender, age, grade classification, Biology I End of Instruction score, race/ethnicity and number of agricultural education courses taken) of students enrolled in selected animal science or horticulture courses in Oklahoma during spring semester 2010?
2. What were the personal characteristics (i.e., age, gender, race/ethnicity, years of teaching experience, certification areas and highest degree held) of instructors who taught selected animal science or horticulture courses in Oklahoma during the spring semester 2010?
3. What was the effect of a science-enhanced curriculum (produced by the Center for Agricultural and Environmental Research and Training [CAERT]) on students' science achievement, as determined by a science proficiency examination?
4. What effect did the science-enhanced CAERT curriculum, designed for animal science or horticulture courses, have on students' agricultural technical skill competence, as determined by state competency examinations for animal science and horticulture?
5. What were selected perceptions of instructors who used the science-enhanced CAERT curriculum to teach selected animal science or horticulture courses during spring semester 2010?

## Null Hypotheses

$H_o1$: The science achievement of students who received the science-enhanced CAERT curriculum in animal science or horticulture will not differ significantly (i.e., $p < .05$) from those students who were taught the traditional animal science or horticulture curriculum, as measured by the TerraNova[3] science achievement examination ($H_o$: $\mu_{1\text{treatment group}} = \mu_{2\text{comparison group}}$).

$H_o2$: The agricultural technical competence of students who received the science-enhanced CAERT curriculum in animal science or horticulture will not differ significantly (i.e., $p < .05$) from those students who received a traditional animal science or horticulture curriculum, as measured by a technical competency test in animal science or horticulture ($H_o$: $\mu_{1\text{ treatment group}} = \mu_{2\text{ comparison group}}$).

## Population

The population for this study consisted of students whose secondary agricultural education instructors held a science credential in Oklahoma during the 2008-2009 school year. The purposeful sample consisted of 10 treatment group students whose teachers were selected by Agricultural Education Division staff of the ODCTE to use the science-enhanced CAERT curriculum developed for the instruction of animal science and horticulture courses during the 2009-2010 school year. In addition, students of 10 different instructors formed a purposeful comparison group. These teachers also held a science credential and were selected according to specific demographic data obtained from the 2008-2009 Computerized Enrollment System for Instructors (CESI) report. The CESI report is used by the ODCTE (2010e), Information Management Division to collect selected characteristics information of Oklahoma secondary agricultural education programs and their students. Therefore, schools that “matched” the treatment group based on review of established criteria were selected to provide an appropriate counterfactual group for the comparison of results.

The criteria used in this study were established and recommended by the National Research Center for Career and Technical Education (NRCCTE), who also provided partial funding for the study. The criteria considered for selection of the counterfactual group included the following. Agricultural education instructors that held an instruction al certification in science at the time of the study, as well as academic performance index (API) scores and socioeconomic status (SES). As such, all students (*N* = 179), whose 20 teachers were selected to participate in the study, were administered agricultural competency examinations. However, random sampling was used to test students' science competence. The instructors' classrooms served as the study's "units of analysis" for purposes of comparison.

## Design of the Study

The design of the study was *ex post facto*, causal comparative because no random assignment of the treatment (or intervention) occurred. The treatment group was "pre-determined" through selection of instructors, i.e., agricultural education teachers who received access to the CAERT curriculum from ODCTE staff. The curriculum was designed to explicate and reinforce scientific principles through the instruction of select agricultural education courses, including modules supported by downloadable lesson plans, aligned learning standards, summary reports, PowerPoint® files, and E-Units (K. Murray, personal communication, October 1, 2009). The CAERT curriculum was selected for use because it was developed according to standards for agricultural education in Oklahoma, acceptable for science credit for college entrance purposes, and consisted of an online delivery method. As a result of the state's alignment, the animal science curriculum included 28 units with 160 instructional lessons, and the horticulture curriculum included 29 units with 148 lessons (CAERT, 2010). The CAERT curriculum is unique because it is a science-enhanced learning resource not otherwise offered by curriculum providers in Oklahoma (K. Murray, personal communication, October 1, 2009).

## Treatment

The treatment tested in this study was a pre-packaged curriculum offered by the Center for Agricultural and Environmental Research and Training (CAERT), Inc. for the instruction of animal science and horticulture. The curriculum was designed to explicate and reinforce scientific principles through the instruction of select agricultural education courses, including modules supported by downloadable lesson plans, aligned learning standards, summary reports, PowerPoint® files, and E-Units (K. Murray, personal communication, October 1, 2009). The treatment group teachers were provided access to the CAERT curriculum via passwords and user names in summer 2009. These teachers were instructed to become familiar with the modules pertaining to animal science and horticulture prior to the beginning of the fall semester. Additionally, this group of teachers was brought onto the ODCTE campus for a one-half day training seminar during September 2009 for an overview of the curriculum (i.e., the functions of the curriculum and how to use its teaching resources).

## Measures of Student Achievement

One of the study's research questions seeks to determine the effect that a science-enhanced curriculum (produced by the Center for Agricultural and Environmental Research and Training [CAERT]) had on students' science achievement, as determined by a science proficiency examination. The examination for use in the study is the TerraNova[3] Form G assessment series examination that was designed and developed by CTB/McGraw-Hill, which is a subsidiary of The McGraw-Hill Companies, Inc.

The examination consists of normed sections that are designed to test student competencies in reading, language, mathematics, social studies and science (Norms Book, 2008). "A normed section is a subset of *TerraNova Third Edition* for which scores from a nationally representative norm group are available" (Norms Book, 2008, p. 1). The normed section for science consists of 40 multiple choice questions with four answer choices that are designed to assess student competencies in science.

To measure the effect of the science-enhanced, CAERT curriculum on students' agricultural knowledge, the ODCTE's online, agricultural education competency-testing program was used. The examination is aligned with Oklahoma skill standards that address a wide range of areas specific to curriculum taught in agricultural education. The tests have 55 questions for each of the curriculum areas in the study. Business and industry representatives in Oklahoma, coupled with agricultural educators, evaluate the skills, knowledge, and competencies needed for successful completion of the subject matter and develop questions accordingly.

## Data Collection

Data collection began in the spring of 2010 with teachers submitting self-reported, fidelity assessments. During the research period, both treatment and comparison group instructors were requested to complete a weekly report intended to measure fidelity of the treatment through an online reporting protocol. Specifically, teachers were asked to identify the courses, units of instruction, instructional topics, types of teaching resources, and types of instructional techniques used to teach the curriculum. At the end of the treatment, data were collected on students' science achievement through administration of the TerraNova[3] science examination. Data describing personal characteristics was also collected from the students and teachers involved in the study at that time as well.

The Oklahoma Department of Education's end of instruction (EOI) examination in science is a part of a larger statewide testing program known as the Oklahoma School Testing Program (OSTP) (Oklahoma State Department of Education, 2010a). Students completing an area of instruction are expected to pass the corresponding standardized assessment. EOI examinations are designed to assess a students' level of competency relative to the Priority Academic Student Skills (PASS), which are Oklahoma content standards (Oklahoma State Department of Education, 2010b). The EOI examination served as the "pre-test" for the establishment of equivalence of groups in this study. The study's intervention continued throughout the 2009-2010 academic school year. The agricultural education subject area competency tests were administered at the end of the spring 2010 semester to determine the effects of the CAERT curriculum on student achievement in agriculture related to either animal science or horticulture.

Student performance was assessed using the TerraNova[3] science achievement examination provided by the NRCCTE. The NRCCTE agreed to provide science examinations and their scoring for 80 students in the study (i.e., four to five students per classroom). As such, 80 students were selected randomly to ensure a strong power analysis and effect size for the study (J. Stone, personal communication, December 3, 2009). Power is typically determined by sample size (Keppel, 1991) and is defined as, "the probability of correctly rejecting a false null hypothesis" (Shavelson, 1996, p. 314). Therefore, one means to increase power is to increase sample size. As power increases, so does the magnitude of the effect, or effect size (Shavelson). "Effect size is the discrepancy between the null hypothesis and the alternative hypothesis of interest" (Shavelson, 1996, p. 317).

An online calculator was used to estimate the appropriate sample size needed for this study (Soper, 2010). It was found, while using three covariates for prediction, that 76 participants were needed to accommodate an alpha level of .05, with an anticipated effect size of .15, and a desired power level of .80. For practical testing purposes, 80 students were randomly chosen from the 20 classrooms involved in the study to participate in taking the science examination. This allowed the researcher to randomly select four to five students per classroom to meet the appropriate sample size for the study.

To measure the effect of the science-enhanced, CAERT curriculum on students' agricultural knowledge, the ODCTE's online, agricultural education competency-testing program was used. Students in Oklahoma have the opportunity to complete a competency examination in their particular curriculum area (ODCTE, 2010d). Students who complete the examination successfully with a score of 70% or better receive a competency certificate and are recognized at the Oklahoma State FFA Convention. The agricultural competency examination is designed to serve as a guide for instruction of the curriculum by the instructor, and to identify student mastery of competencies and skill objectives needed for employment in the agricultural industry. As such, this examination could serve as a potential form of accountability for students' receipt of course credit (ODCTE, 2010d). To achieve this study's purpose, competency examinations in the areas of animal science and horticulture were used. Because the agricultural competency tests are online and not cost prohibitive, all students in the study ($N$ = 500) were encouraged to take the agricultural competency examination congruent with their course of study (i.e., animal science or horticulture).

School district testing liaisons arranged for and proctored the examinations. The examinations are aligned with Oklahoma skill standards that address a wide range of precise areas specific to curriculum taught in agricultural education. Business and industry representatives in Oklahoma, coupled with agricultural educators, determine the skills, knowledge, and competencies needed for successful proficiency of the subject matter and develop questions accordingly. These competency examinations were taken by students at the end of the 2010 spring semester (~ late April). The examination scores needed to determine the level of students' agricultural technical competency were obtained through the ODCTE's assessment specialist who facilitated the examination procedure.

## Data Analysis

Five research questions were identified to guide the study. It was determined that describing select characteristics of the teachers and students who participated in the study was essential. To summarize trends and tendencies related to the participants' characteristics descriptive statistics, i.e., mean, median, mode, frequency, and percentages were utilized to analyze selected teacher and student personal and educational variables. Creswell (2008) identified that descriptive statistics help to provide an insight on research data through understanding how much variance may exist in collected data and allowing for some insight into how data compares with similar subjects or groups.

Teachers selected for the study were asked to answer questions describing gender, age, teaching experience, race/ethnicity, educational level, content area specialization(s), and whether or not they held a traditional or alternative teacher certification. Student participants were asked to identify characteristics pertaining to gender, age, grade classification, race/ethnicity, and number of agricultural education classes they had taken previously.

## Results

### *Students*

For the treatment group students, it was determined that a majority of the participants were female (55%) and were White/Caucasian (83%). Most of the students (45%) fell in the 18 years or older age category; 48% of the students reported they were seniors and 38% indicated being sophomores.

For the comparison group, it was determined that a majority of participating students were female (55%) and White/Caucasian (85%). Most of the students comprised the age categories of 16 (38%) and 17 (28%); 43% of the students indicated sophomore as their classification and 25% were seniors.

*Teachers*

The treatment group teachers consisted primarily of male instructors (75%) who were 50 to 59 years of age (75%) and had 21 or more years (75%) of teaching experience. All of these teachers were White/Caucasian and had earned a traditional teaching certificate. Fifty percent of these teachers had obtained a master's degree as part of their educational preparation, with one-half of those identifying secondary administration as an area of specialization.

The comparison group consisted primarily of male teachers (86%) who were 50 to 59 years of age (57%) with 21 or more years (71%) of teaching experience. Eighty–six percent of the comparison group instructors self-selected White/Caucasian as their Race/Ethnicity, and 14% identified themselves as American Indian/Alaskan Native/Pacific Islander. All of these instructors held a traditional teaching certification. A majority (57%) of the instructors held either a Bachelor of Science or Bachelor of Arts degree, and 29% had earned a master's degree. Of those, 14% self-reported a specialization in education.

No statistically significant difference between the treatment and comparison groups regarding science achievement was found. However, the mean score of the treatment group was slightly larger than the comparison group indicating a slightly higher achievement level; a "Small" effect size ($d$ = .16) for this difference was calculated.

However, the researcher failed to reject the null hypothesis ($H_o1$).

It was determined in research question four, that a statistically significant difference ($p < .05$) existed in agriculture competency scores in animal science ($p = .001$) and horticulture ($p = .000$) as a result of the treatment. Moreover, this was considered to be a "very large" effect ($d = 1.18$) in animal science and a "large" effect ($d = .92$) in horticulture. It was determined that a positive effect, statistically and practically, existed regarding the agricultural competency (i.e., animal science and horticulture) of those students who received the treatment. As such, the null hypothesis ($H_o2$) that indicated that the agricultural technical competence of students who received the science-enhanced CAERT curriculum in animal science or horticulture will not differ significantly (i.e., $p < .05$) from those students who received a traditional animal science or horticulture curriculum, as measured by a technical competency test in animal science or horticulture ($H_o$: $\mu_{1 \text{ treatment group}} = \mu_{2 \text{ comparison group}}$) was rejected. As such, indicating that the science-enhanced CAERT curriculum had a positive and statistically significant effect on students' technical competency.

Analysis of the qualitative data provided by the treatment group instructors revealed limited results because only two responded to the related questionnaire. The curriculum was preferred by both instructors and it was expressed that the online format of instruction appealed more to the students as a result of it "fitting" their learning style better. It also was noted that the curriculum was enriched with science content without presenting concepts to the students that were too difficult to grasp. However, some barriers to using the curriculum were identified. It was described by the instructors that when this computer and/or Internet technology on the local level failed, it was very discouraging. It was further identified that a major issue with the curriculum existed in the curriculum's PowerPoints®. Most were considered to be "crowded" and cumbersome in displaying content, and that students stated they could produce better PowerPoints® than those included in the curriculum.

## Conclusions

### *Research Question One*

This study found that a majority of those students who participated were female. In fact, 55% of the students in the treatment and comparison groups were female. Further, in terms of Race/Ethnicity, the category representing the majority of both groups (treatment and comparison) was White/Caucasian. Finally, most students were 16 years of age or older and belonged to the sophomore and senior classes primarily.

### *Research Question Two*

In regard to research question two, the teachers who participated in this study were male and White/Caucasian predominantly. A majority of the instructors reported being between 50 and 59 years of age and had accrued 21 or more years of teaching experience. Moreover, it was determined that one-half of the instructors in the treatment group held a master's degree, and each had earned traditional certification to teach agricultural education in Oklahoma. In comparison, 29% of instructors in the comparison group had a master's degree, and all held a traditional teaching certification.

*Research Question Three*

When considering student achievement in science, this study found that the use of a science-enhanced curriculum produced by the Center for Agricultural and Environmental Research and Training (CAERT) did not result in a statistically significant increase ($p < .05$) in student performance as determined by the TerraNova[3] science proficiency examination. Therefore, null hypothesis one ($H_o1$) was not rejected. However, small practical differences were detected between the groups, as student performance score means in the treatment group were more than two and one-half points greater than the means of students' performance scores in the comparison group. Although not statistically significant, these results are similar to findings reported by Roegge and Russell (1990).

*Research Question Four*

Although the science-enhanced, CAERT curriculum failed to make a statistically significant difference on students' science achievement, as measured by the TerraNova[3] examination, it did have a statistically significant effect ($p < .05$) on their ability to learn agriculture (i.e., animal science and horticulture). This finding is consistent with research by Parr, Edwards and Leising (2006) and Young, Edwards and Leising (2009) who found that agricultural content knowledge did not diminish when the integration of mathematics occurred in Oklahoma's agricultural power and technology curriculum.

Specifically, students in the treatment group scored nearly six points higher on the horticulture competency examination than did students in the comparison group. Likewise, students in the treatment group scored nearly nine points higher on the animal science competency examination than did students in the comparison group. This finding may be intriguing especially because the comparison group students had higher Biology I EOI scores (pre-test) as compared to the treatment group students. The effect sizes for the animal science and horticulture curricula were “large” and “very large,” respectively, supporting research by Bottoms (1998) who concluded that greater achievement can be realized through an integrated curriculum. So, students’ whose instructors taught using the CAERT curriculum scored significantly better on tests of their technical competency than students whose instructors used a traditional curriculum and taught as they always had.

*Research Question Five*

Regarding research question five, this study found that similar perceptions existed between those instructors ($n$ = 2) who used the science-enhanced CAERT curriculum. In essence, the CAERT curriculum was perceived as being “convenient” due to its electronic format. Further, teachers stated that the CAERT curriculum was current and contained the latest information at an affordable price. The instructors believed that the curriculum was complete, rigorous, and more engaging than curriculums they had used in the past.

Teachers noted that the curriculum was rigorous and challenging to students, yet it did not present concepts deemed too difficult for them to grasp. They also described how the students seemed to enjoy using the curriculum, and that the online aspect of the curriculum “fit” the students’ preferred learning styles (i.e., “digital natives”; Prensky, 2001).

When asked about their perceptions of barriers and limitations of the curriculum associated with student use, the general consensus of those surveyed related to technological difficulties. Teachers recognized that most of the students did not have access to high speed Internet connections outside of the typical school day. And, those who did have access to Internet connections were on dial up systems primarily, which were not fast enough to access the curriculum from home. Moreover, teachers noted that when servers were down at the school, the online curriculum was ineffective. As such, teachers were forced to use other media and/or means for conducting class.

Additionally, teachers recognized that they were not competent enough, technologically, to be comfortable with the online delivery method. This finding is reinforced through Prensky (2001a), who stated that the digital immigrants ". . . typically have very little appreciation for these new skills that the natives have acquired and perfected through years of interaction and practice" (p. 2). The teachers expressed that they trained inadequately in the use of the curriculum, and suggested that additional training be offered on how to use the curriculum properly. It was also perceived that too much extra preparation time was needed to modify the PowerPoints® provided with resource to align instruction with local community needs. This was not strictly a localized phenomenon, as communication between instructors who used the curriculum supported this view.

## Recommendations

### *Recommendations for Research*

Although the findings of this study did not indicate a statistically significant difference in science achievement of the treatment group students, hope exists that the intervention (ie., the science-enhanced, CAERT curriculum) has potential in this area.

However, future research is needed. Because the treatment sample was pre-determined by ODCTE staff, the generalizability of this study suffers. As such, this study should be replicated with teachers who are randomly selected in an effort to generalize the findings more broadly.

A future investigation should occur with a different sample of teachers to determine if the science-enhanced curriculum was the determining factor in the outcome of the research that was conducted, or if it was a result of teacher effect. To answer this question, an HLM analysis should be conducted. Further, this study should be replicated with a true experimental design. Teachers and students should be randomly selected and assigned in future studies to be able to generalize the findings more broadly.

Future research should also be conducted to determine which mode of curriculum delivery students prefer best. From a pedagogical perspective (Brazen & Clark, 2005), it is important to determine which teaching methods have the most impact on student learning. Teaching methods that create synaptic interactions in the brain, as posited by Caine and Caine (1990) and Diamond (1985), “affects our capacity to learn” (Caine & Caine, 1990, p. 66). So, assuming these students were “digital natives” and “pre-disposed” to an electrical/digital delivery of information, teaching methods and curriculums designed or intended to create synaptic interactions in the brain should be investigated. This study lacked prolonged, sustained professional development regarding pedagogy needed to teach science content effectively (i.e., inquiry-based teaching method). Therefore, future research should determine if a student-centered approach (i.e., inquiry-based learning) has an effect on students’ ability to learn science in the context of agriculture when compared to a teacher-centered approach (i.e., lecture).

Moreover, this study supports the research by Brashears et al. (2005) where curricula that include an audio/video support to "traditional" instruction is capable of significantly affecting student achievement over the use of text alone. This method of instructional delivery further references the work of Woolsey and Bellamy (1997) and their claim of computers and their applications finding their way into effective science instruction.

Additionally, it was determined that the science-enhanced CAERT curriculum had a statistically and practically significant effect on students' achievement in animal science ($p$ = .001, $d$ = 1.18) and horticulture ($p$ = .000, $d$ = .92). These results are promising and reinforce assertions by Myers and Dyer (2006) who stated, "The scientific literacy needs of individuals entering careers in agriculture are becoming increasingly important" (p. 52). Accordingly, the science-enhanced CAERT curriculum, which is designed to reinforce the science achievement of students through contextual delivery of agricultural content, would in fact meet the learning needs of students entering the workforce. As such, this curriculum (CAERT) supports the need for science literacy, as posited by Collins (1998) and Myers and Dyer (2006).

Additionally, Phipps et al. (2008) posited that the agricultural education program should be maintained by "Developing knowledge and skill in agriculture and natural resources to support the industry, occupational needs, and personal interests of students" (p. 3). Posits made by Myers and Dyer (2006) and Phipps et al. (2008) are encouraging, and indicative of the need for a curriculum that fully aligns with the PASS skills in Oklahoma for science. To reinforce the findings of this study, additional research should be replicated with other teachers and students to understand better the validity of the science-enhanced, CAERT curriculum for the purpose of affecting students' ability to learn agricultural content.

Additionally, it could be instructive to re-test these same students on their agricultural competencies to determine how much learning was retained. In other words, did the treatment group students retain knowledge related to agricultural technical competencies longer or with a higher degree of accuracy than the comparison group? Or, could this simply be explained by the Hawthorne effect, which is "an effect on the dependent variable resulting from the treatment group's knowledge that the members are participating in an experiment" (Ary et al., 2002, p. 560)? Future research should examine this phenomenon.

As a part of the research design, instructors were asked to provide evidence of instruction and techniques that were used in the classroom. Fidelity reports submitted by the instructors should be assessed to see what differences might have existed between instructor's teaching techniques. Could the differences in students' scores be attributed to the impact of the teacher? Perhaps teachers in the treatment group taught more effectively sans the role of the CAERT curriculum. Also, would the use of other curriculums in addition to CAERT have negated the effect of the science-enhanced curriculum? Future research should explore these phenomena.

Also, future inquiries should compare the agricultural backgrounds of those students who were selected to participate in the TerraNova[3] assessments. It could be that the students in the treatment group had higher GPAs and were more scientifically literate than their counterparts in the comparison group.

The qualitative data yielded the finding that the instructors' viewpoint, the online aspect of the curriculum was both a barrier to the instructor as well as a delivery method that fit the current learning style of the students. Prensky (2001a) identified this on-line method of delivery as an adaptable method of instruction that students are more used to, as compared to the instructional styles (i.e., lecture, question, answer and discussion [QAD]) traditionally used by those instructors that have 21 or more years of teaching experience as self reported by the instructors in this study. Research needs to be conducted as to the "digital immigrant" instructors' ability to effectively teach with this type of curriculum and what adaptations may be needed to increase their self-efficacy with this instructional format.

*Recommendations for Practice*

The science achievement of students who were exposed to the study's treatment (i.e., the science-enhanced, CAERT curriculum) yielded promising results. The integration of a science-enhanced curriculum into a program of agricultural education did increase the science achievement of students. Edling (1993) stated that, "Learning is greatly strengthened if concrete examples or situations familiar to the student can be utilized in the learning process" (Contextual learning section, para. 2). Put simply, students are capable of learning better when information is presented to them in a way that it best relates to their personal experiences. As a result of the conclusions of this study and others, (i.e., Parr et al., 2006; Young et al., 2009), improvements in student achievement can be realized as a result of teachers integrating curriculum. Therefore, it is recommended that agriculture teachers collaborate with their science teacher colleagues in the development and reinforcement of learning resources that support and supplement the science aspects of the agriculture curriculum. Potentially, through this collaboration, teachers may become more efficacious in their perceived abilities to teach science through an agricultural context (Balschweid & Huerta, 2008; Balschweid, 2002; Balschweid & Thompson, 2002; Balschweid et al., 2000; Chiasson & Burnett, 2001; Connors & Elliot, 1995; Fraze, 1993; Ramsey & Edwards, 2004; Ricketts et al., 2006; Roegge & Russell, 1990; Thompson & Balschweid, 2000).

The results of this study should be made available to stakeholder groups, such as school administrators and key teachers at the state and national levels who are charged with the improvement of professional development opportunities available to secondary education instructors. Additionally, attrition rates were a concern in the study. Stakeholder groups, state leaders, and policy makers should be made aware of this concern, and encourage teachers to participate fully in future studies' entirety. The treatment group instructors expressed that additional training would be necessary for the instructors to feel "comfortable" with the curriculum delivery format. A one-half day in-service was presented to help teachers in using the curriculum. It is recommended that additional, sustained professional development be devoted to assisting teachers in using the CAERT curriculum as well as similar science rich learning resources.

Moreover, a "communities of practice" should be established between agriculture teachers and the science teacher at the school. Chalmers and Keown (2006) identified this as a cost-effective practice for providing professional development to teachers, which could also reinforce the self-efficacy of instructors in teaching the science content inherent to their curricula. Further, professional development should focus on helping instructors understand the use and format of the CAERT curriculum better. Specifically, workshops should focus on helping teachers learn ways to emphasize science concepts effectively as well as assist teachers in acquiring the pedagogical practices supporting inquiry-based teaching.

The science-enhanced CAERT curriculum should be compared to the "traditional" curriculum used currently in Oklahoma to determine where differences exist. Once identified, the "traditional" curriculum could be revised and enriched to meet the needs of students better. Further, the agricultural technical competency examination should be crosswalked with both curriculums (i.e., CAERT and "traditional") to determine how many of the test items are represented in each respective curriculum. It could be that the CAERT curriculum is more aligned "naturally" to the agricultural technical competency examination than is the "traditional" curriculum.

## Limitations

As a result of variables outside of the control of the researcher, certain limitations existed. For example, treatment teachers were selected purposefully by ODCTE state staff. Because randomization did not occur with teacher selection, the generalizability of the study suffered. Additionally, EOI data were not accessible on each student who participated in the study. The researchers attempted to acquire EOI scores from independent schools on multiple occasions. However, in Oklahoma, each school district "houses" its own student database (i.e., EOI results). As such, some schools were reluctant to release those data for the purpose of the study. Further, no incentives were provided for the teachers to participate in this study. As such, some teachers chose not to provide fidelity reports, use the curriculum in its entirety, or test their students accordingly.

## Implications

As a result of the curricular intervention, this study has shown potential for improving student achievement in science through a contextual delivery method. This implication is consistent with other studies that emphasized science (e.g., Balschweid, 2002; Chiasson & Burnett, 2001; Ricketts et al., 2006; and Roegge & Russell, 1990), as well as in a different academic areas (e.g., Parr et al., 2006; 2009; and Young, 2006).

Many of the instructor's in this study had 21 or more years of teaching experience and all held a science endorsement or certification. Future research should be conducted with regard to the teaching experiences and instructor certification areas. Is it possible that having an additional teacher certification in science, some of the teachers may have actually taught science in Oklahoma before they became an agriculture teacher? If so, could this have been a confounding variable that affected the study's outcomes? Further, is it possible that any additional certifications, such as in mathematics, English language arts, or any other curricular area, increased the abilities of either the treatment or comparison groups? Additional research should address these phenomena.

Is it possible that this teacher experience added to the effects of the science-enhanced curriculum making it more effective for a contextual learning experience? Dewey (1938) argued for the integration of academics and vocational training as a way to reinforce the principles of learning thereby allowing for the development of life skills readily transferable across contextual areas. That position speaks to the potential for a science-enhanced curriculum being effective, regardless of students' prior instructional experiences.

Is it possible that a more youthful teacher group (i.e., “digital native”) with less teaching experience might have an effect on students’ abilities to learn science? Many of the teachers in this study had an extensive amount of teaching experience (21 or more years) and belonged to Prensky’s (2001a) “digital immigrant” classification. Perhaps the teachers in this study were not “ready” to use this form of curricular technology. If so, maybe their “digital native” counterparts could achieve different results.

Further, perhaps students in the treatment group had more extensive agricultural backgrounds, interest, understanding or other untested but confounding variables, than did students in the comparison group. It is even possible that students in the treatment group could have had an extensive amount of courses in the biological sciences, thus providing them with an advantage in content over the comparison group. The personal characteristics information identified that the treatment group had a higher percentage of older students with a higher level of education. Therefore, it is feasible to think that those students had more background in science education and made them more likely to score higher on a science achievement examination.

Is it possible that increased exposure to the science-enhanced curriculum would have a stronger effect on the science achievement of those students who received the treatment? Parr (2004), in his study on the effects that a math-enhanced curriculum and instructional approach had on the mathematics achievement of agricultural power and technology students, stated that “perhaps the short time period over which the study was conducted did not allow enough time for significant differences in student math achievement to emerge” (p. 110). Likewise, perhaps the short duration (i.e., spring 2010 semester) during which this intervention occurred did not provide enough time for significant differences in students' science achievement to emerge. Is it possible that perhaps the comparison group teachers were doing a good job of emphasizing the science inherent to agriculture in the traditional curriculum already? Perhaps teachers in Oklahoma are already teaching a high level of science in their classes. This could account for the lack of a statistically significant difference in science achievement by the treatment group. In addition to the increased instructional time, would some of the instances of mortality or non-compliance in the study been lessened if some form of monetary reward for participation was involved?

Implications exist per curriculum enhancement as well. Why did the CAERT curriculum have a positive effect on students' ability to learn agriculture? Is the "traditional" agriculture curriculum outdated and in need of revision? The results of the study indicated that a statistically significant difference ($p < .05$) in agricultural competency scores was found for those students who received the treatment (i.e., the science-enhanced, CAERT curriculum). Is it possible that the curriculum not only delivered science content effectively, but also exposed the students to more rigorous or meaningful agricultural content? Because the teachers in the treatment group knew they had been selected by state staff (ODCTE) to receive special treatment per acceptance of the CAERT curriculum, did they teach with more focus or intent than the comparison group teachers? Or, maybe because of its digital mode of delivery, the intervention (i.e., the CAERT curriculum) was more meaningful, relevant, and appealing to the presumably "digital native" students because it was digitally-based (Prensky, 2001a). Prensky noted that today's students have changed drastically and are not "in tune" with traditional pedagogical methods of instruction. Perhaps those teachers comprising the comparison group were more “traditional” in their mode of delivering course content. If so, this would support research by Brazen and Clark (2005) who asserted that teachers who continue to rely on the lecture format or other traditional methods of instruction (i.e., lecture, overhead projection and handouts etc.) solely are deemed less effective in the classroom. Moreover, could the results of the study be attributed to the online delivery of the curriculum because it was a more effective science instructional method for the students studied (Woolsey & Bellamy, 1997)?

Balschweid et al. (2000) posited that an integrated contextually-based, science-enhanced curriculum that was taught to pre-service agricultural education teachers could be a catalyst toward their increased collaboration with science teachers and the integration of science in the courses they teach. In order to increase the instances of cross-curricular integration in secondary education, might integration experiences at the pre-service level motivate future teachers to include more science-enhanced curricula as a result? It is widely accepted that “teachers often teach as they are taught” (Murphrey, Miller, & Roberts, 2009, p. 98); therefore, it is imperative that pre-service teachers use new technologies including curriculums, during their preparation with the aim of improving their in-service practice in the future.

## Major Contributions of this Study

### *Contribution to Literature*

Little empirical evidence exists in the literature base that demonstrates whether teaching a science-enhanced curriculum in the context of animal or plant science courses affect student achievement in science positively. Further, little is known as to how teaching a science-enhanced curriculum would affect students' agricultural content knowledge, generally. This study provided rationale that when teachers in Oklahoma emphasize science in the context of agriculture, their students learn science and agriculture better. This finding is encouraging, especially in the age of accountability. The findings of this study should speak well on agricultural education teachers' ability to compliment science instruction in an effort to help students learn and apply science better. This study also provides support to imply that perhaps agricultural education teachers are already integrating a high level of science into their agricultural curriculums (i.e., animal science and horticulture).

*Contribution to Research*

This causal comparative study allowed for the use of inferential statistics and compared students in a treatment and comparison group on standardized examinations in science (i.e., TerraNova[3]) and agriculture (i.e., industry-based competency tests in animal science and horticulture). Although, teachers were not incentivized to participate in the study and were not offered professional development in the pedagogical practices needed to teach science effectively (i.e., inquiry-based teaching methods), students in the treatment group still learned science better than did their comparative group counterparts. Future research should explore a true experimental design and incentivize teachers monetarily in hopes of improving attrition rates and optimizing the data resulting from the study.

*Contribution to Practice*

Although, no statistically significant differences were found in students' science knowledge when comparing the treatment and control group, this study showed that agricultural education teachers in Oklahoma can impact students' abilities to learn science positively. Further, a major finding of this study was that when teachers emphasize science more intently, students learn agriculture better. Therefore, teachers should be encouraged to teach science in the context of agriculture without fear of diminishing students' learning of agriculture content.

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APPPENDICES

# APPENDIX A

# STUDENT PERSONAL CHARACTERISTICS QUESTIONNAIRE

**Department of Agricultural Education, Communications and Leadership**

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*Student Personal characteristics Questionnaire*

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**Student State Identification Number ___________________________________**

**Teacher / School Code _______________________________________________**

**Please select the response which best describes you:**

1. Gender of Student:
   - ☐ Male
   - ☐ Female

2. What is your age?
   - ☐ 14
   - ☐ 15
   - ☐ 16
   - ☐ 17
   - ☐ 18 or older

3. What is your current grade classification?
   - ☐ Eighth Grade
   - ☐ Ninth Grade—Freshmen
   - ☐ Tenth Grade—Sophomore
   - ☐ Eleventh Grade—Junior
   - ☐ Twelfth Grade— Senior

4. Including your current class, how many agricultural education classes have you taken? __________

5. Which of the following race/ethnicity categories do you belong to?
   - ☐ White / Caucasian
   - ☐ African–American

☐ Asian
☐ American Indian / Alaskan Native / Pacific Islander
☐ Other

APPENDIX B

TEACHER PERSONAL CHARACTERISITCS QUESTIONNAIRE

TEACHING

**Department of Agricultural Education, Communications and Leadership**

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*Teacher Personal characteristics Questionnaire*

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**Please select the response which best describes you:**

1. What is your gender?

   ☐Male
   ☐Female

2. What is your age?
   ☐ 20–29
   ☐ 30–39
   ☐ 40–49
   ☐ 50–59
   ☐ 60 or older

3. What are your years of teaching experience?
   ☐ 0–5
   ☐ 6–10
   ☐ 11–15
   ☐ 16–20
   ☐ 21 or more

4. Which of the following race/ethnicity categories do you belong to?
   ☐White / Caucasian
   ☐African–American
   ☐Asian
   ☐American Indian / Alaskan Native / Pacific Islander

☐Other

(Over)

5. What is your highest degree held?
   ☐ Bachelor's
   ☐ Some post graduate work
   ☐ Master's
   ☐ Ph.D. or Ed. D

6. What are your degree areas and specializations?

   ______________________________________
   ______________________________________
   ______________________________________
   ______________________________________
   ______________________________________

7. Which of the following best describes your teaching certification?
   ☐ Traditional
   ☐ Alternative

# APPENDIX C

## POST TEST ADMINISTRATION INSTRUCTIONS

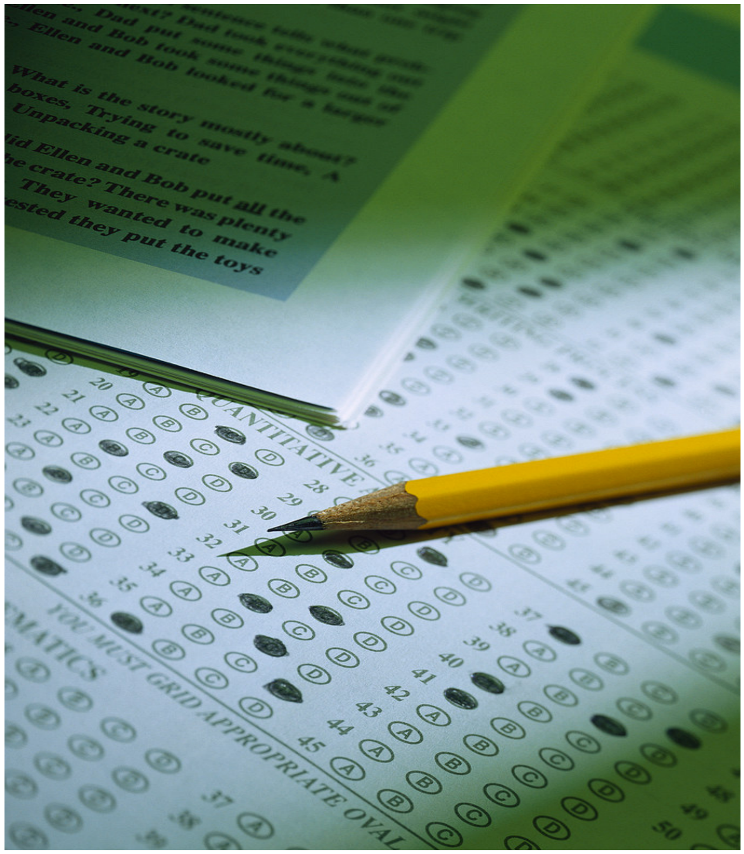
# Post–Test Administration Instructions

## *Science Curriculum Study*

***Oklahoma Department of Career and Technology Education***

***Department of Agricultural Education, Communications & Leadership – Oklahoma State University***

***Spring 2010***



## INTRODUCTION

Thank you once again for agreeing to serve as a test administrator for the Science–Enhanced Curriculum study. This study is being conducted by the Department of Agricultural Education, Communications and Leadership at Oklahoma State University in collaboration with the Oklahoma Department of Career and Technology Education. The Science–Enhanced Curriculum study involves the post–test of students at the conclusion of the spring term 2010.

**Please have your local testing liaison administrator this test.**

This booklet contains **Post–Test Administration Instructions**. The post–test is critical to the study because it will help researchers determine if the classroom intervention improved the science knowledge and skills of students.

If you have questions about the study or the test administration, please contact the Oklahoma State University Project Director:

J. Chris Haynes, chris.haynes@okstate.edu or 405–744–3036

Or

Kurt Murray, kmurr@okcareertech.org or 405–743–5489

## Items Needed for Examination Administration

### Please arrange to have all materials in advance of examination administration

- TerraNova, Third Edition Test Booklets (Provided)
- TerraNova, Third Edition Answer Sheets (Provided)
- Test Administrator Direction Sheet (Provided)
- Student Personal Characteristics Response Sheets (Provided)
- Parental Permission Sheet (Provided)
- Student Assent Sheet (Provided)
- Student state identification number
- Number 2 pencils with erasers
- Extra erasers
- Return shipping label/postage (Provided)

If any materials are missing or you do not have the number of tests designated for your school, please notify Chris Haynes immediately at: 405–744–3036.

**All testing materials must be stored in a secured location before and after test administrations.**

## SCHEDULING POST–TEST DATES AND TIMES

- For the post–test administration, we will collect data using one instrument, the TerraNova, Third Edition, Complete Battery, Level 21/22. We will test the Science section only.

- The science section of the TerraNova will require exactly 40 minutes to complete. However, this does not allow time for distributing the test materials and giving instructions to the students.

- Please plan carefully so there is enough time to distribute materials and give students test instructions before the exam, and to collect the materials at the end of the exam.

  A class period of 55 minutes or longer should be adequate for the test administration

  If the class period is less than 55 minutes, please work with your agriculture teacher to arrange an alternate time for the test administration.

- Plan in advance for accommodating students with special needs; follow their IEP plans on file at your school.

## HANDLING TEACHER AND STUDENT CODES

### Please read this section carefully.

In order to protect the privacy and confidentiality of the teachers and students, and to ensure that we collect valid data from the post–test administration, please ensure that the students state identification number is accurately identified on both the testing booklet answer sheet as well as the student personal characteristics questionnaire.

Please follow these steps:

1. The Terra Nova answer sheets will come to you pre–coded with a teacher/school code pre–determined by the researchers at Oklahoma State University. Please double–check to make sure the teacher code used on the Terra Nova answer sheets and the student personal characteristics questionnaire is one and the same. Please correct any discrepancies.

2. At the time of testing, you will need to provide students their OK state ID numbers. Please follow your state/school protocol to provide the IDs to the students.

3. The students' OK state ID numbers will also need to be entered on the Terra Nova answer sheets as well as the student personal characteristics questionnaire. When the test administration is complete, please ensure that the OK state ID number matches on both the test and the personal characteristics questionnaire.

   NOTE: It is very important that NO STUDENT or TEACHER NAMES be written on the form. The researchers cannot link names to codes.

4. At the conclusion of the test, please use the provided envelope for return of all of the test materials and returned permission slips. Please note that it is not required for parent permission slips to be returned according to the specifications on the permission slip.

## FOLLOWING STANDARDIZED TESTING PROCEDURES

To ensure that test results are valid, reliable, and equitable, standardized tests are always administered using the same directions and same time limits at each administration. If the tests are not administered with the same procedures, valid conclusions cannot be drawn from the test results.

- Please keep all testing materials in a **secured location** where they cannot be accessed by teaching staff, students, or other school personnel.

- During the administration, make sure students understand the directions and how to mark answers. You may assist them with test–taking mechanics, but be careful not to inadvertently give hints or clues that indicate an answer or help eliminate answer choices.

- Encourage students to attempt to answer as many items as they can. Ask them to read each question carefully and make their best attempt at answering. Be careful not to imply that they should guess randomly.

- If a student is obviously marking answers randomly, remind the student that the test is important and we would like their best effort.

- Special circumstances, interruptions, or distractions that affect individual or group performance can result in non–valid tests. Note all disturbances or special circumstances in writing and inform the testing coordinator when you return the testing materials.

- Special education and special needs students should follow the same protocol or IEP plan they use to take other standardized tests.

## POST–TEST ADMINISTRATION

**NOTE: Participation in the test is voluntary. If students possess a note from their parents/guardians indicating they are not to participate, or if they otherwise indicate they do not want to participate, they are not required to do so. They can be provided an alternative activity.**

1. **Welcome the students to class.**

2. **Instruct students to put all items on the floor.**

3. **Distribute ALL testing materials to the students before the administration.**

Each student should receive her/his OK State ID number for entry on the TerraNova answer sheet.

Each student should receive a TerraNova test booklet, a TerraNova Answer Sheet, a personal characteristics questionnaire, and a number 2 pencil.

Instruct the students NOT to open their TerraNova test booklets until directed to do so.

4. **Instruct students to fill in their OK State ID numbers into the "student code" area (bottom left hand corner front cover) on the Terra Nova answer sheet. <u>Inform students that no other areas of the front page of the TerraNova answer sheet need to be completed, just the ID code.</u>**

   **Important**: Hold up the TerraNova answer sheet and point to show where the student ID should be entered.

   - Direct students NOT to use their social security numbers.
   - Direct students NOT to write their own names, their teachers' names, or school names on any of the test materials.
   - As needed, explain to students that the ID numbers are used to align the post–tests with the student personal characteristics questionnaires so that their names will not be associated with their answers.
   - As needed, assure students that their names will not be matched to their ID numbers and will remain confidential.

5. **If the ID numbers were distributed to the students on separate pieces of paper, collect them for secure disposal.**

## ADMINISTRATION OF THE TERRA NOVA TEST

Once the students have filled in their ID numbers on the TerraNova Answer Sheet, you may begin administration of the test.

Take a moment to help your students find the "Science" section of the test book and on the scantron answer sheet. You can tell students that they WILL NOT be tested on the other subject areas of the test booklet. They will only be completing the SCIENCE section.

Ask students to turn to the "Science" section of the book numbered Page 57. Read the following script (in **BOLD TEXT)** to the class:

> **Open your test booklet to page 57, the Science test. Be sure to you are in the section that says "Science" at the bottom of the page. It is a little more than halfway through the test booklet. <u>You will not be tested on the other subject areas in the book.</u>**
>
> **Now, open your <u>answer sheet</u> to the Science section at the top of Page 4. The science test has 40 questions; the answer sheet has space for 40 answers.**

It will help to hold up the booklet and point to the test booklet and the answer sheet. Check to see that all students are on the correct page in their test books and answer sheets.

Read this script:

> **In this test, you will mark your answer on your answer sheets. Fill in only the circle that goes with the answer you choose. Be sure to fill in the circle completely and make your mark heavy and dark. If you want to change an answer, completely erase the mark you made before making a new mark.**

Begin with Sample A. <u>Do not read the sample question out loud</u>. Read this script to the students:

> **We will begin by doing the sample question. Read the sample question and mark your answer in the shaded box on the answer sheet. When you have finished, do not turn the page.**

Give students time to answer Sample A. Discuss the sample if needed. The correct answer is C.

Once students have completed the Sample, continue with the script:

**For this test, you will answer Questions 1 through 40 of the Science test.**

**Remember to read all of the directions and information in this section of the booklet. The important thing is to do your best. Read each question carefully and answer to the best of your ability. Even if you do not finish, we want to know how well you can do on the questions that you do finish.**

**When you come to the word "STOP," you have finished the Science test. You may go back over the Science test and check your answers.**
**When you have finished, sit quietly until everyone else has finished.**

**Are there any questions?**

**You will have 40 minutes to answer as many questions as you can. Be sure to stay on the pages that say "Science" at the bottom. Periodically check to make sure you are on the correct number on your answer sheet.**

**Now, turn the page. You may begin.**

Record the starting time:___________

Allow 40 minutes for the test. Check around the room to be sure that students are in the right place on their answer sheet and are filling in circles correctly.

Record the stopping time: __________

**STOP. This is the end of the Science Test. Make sure that you have marked all of your answers clearly and that you have completely erased any marks you do not want. Thank you for working so hard.**

Collect the test booklets and answer sheets. The students are now finished.

# RETURNING THE TEST MATERIALS

Below are the procedures to follow in preparing test materials for shipping:

**At no time should the researchers receive any information that links student names, teacher names, or school names to the testing data.**

1. **Test Materials Check–in Form**. Immediately after the test administration, please do the following:

    - ✓ Check to see that all student IDs and codes were properly entered on the answer sheets. Make corrections of obvious mistakes and flag those that cannot be corrected using a post–it note.
    - ✓ Check that no names of students, teachers, or schools names appear on the answer sheet. If they have been written onto either, please erase using an art gum eraser.
    - ✓ Remove all extraneous markings (drawings, notes, calculations, etc.) from the answer sheets using an art gum eraser.
    - ✓ Check for unusual patterns in the bubbles on the answer sheets; flag any that look suspect with a post–it note.
    - ✓ Flag all answer sheets that represent special circumstances using post–it notes (e.g. tests in which students may have intentionally answered inappropriately, answer sheets that were returned blank, damaged answer sheets, etc.)
    - ✓ <u>Include this check–in sheet with your return shipment</u>.

2. **Test Administration Notes.** Please include any information that you feel may be essential to the outcome of the test on separate paper documentation and include it in the return package.

3. **Sort the USED test booklets and answer sheets into separate piles for shipping.** IMPORTANT: <u>Do not use rubber bands to bind the Terra Nova answer sheets.</u> This can tear and fray the edges of the paper and prevent accurate scoring.

4. **You may package all materials in the provided shipping envelope**, using the return shipping label provided.

*Thank you!*

# APPENDIX D

# WEEKLY REPORT

Weekly Report

School ________________ Instructor ________________ Date of Instruction _____________

Please identify the appropriate selection(s) in the check box provided. If you are providing data for more than one course please check each appropriate box.

*Ex.*

- √ *Animal Science*
- □ *Plant and Soil Science*
- √ *Horticulture/Botany*

1. Select the course(s) you are reporting on for this weekly report. (*Select all that apply*)
   - □ Animal Science
   - □ Plant and Soil Science
   - □ Horticulture / Botany

2. Identify the unit(s) of instruction taught during this reporting period. (*Select all that apply*)
   (Each of the units titles will be contained in a drop down selection list)
   Plant and Soil Science (*Select all that apply*)

Unit PLS1: Importance and use of plants and plant products (12 hours)
Unit PLS2: Career entry and advancement in plant– and soils–related industries (10 hours)
Unit PLS3: Plant and soil safety (5 hours)
Unit PLS4: Sustainable plant production (10 hours)
Unit PLS5: Plant biology (35 hours)
Unit PLS6: Plant growth (35 hours)
Unit PLS7: Soil science (30 hours)
Unit PLS8: Plant cultural practices (30 hours)
Unit PLS9: Agricultural education (13 hours)

Animal Science (*Select all that apply*)

Unit ANS1: Nature and importance of agricultural animals (14 hours)

Unit ANS2: Career entry and advancement in the animal industry (10 hours)
Unit ANS3: Personal and occupational safety in the animal industry (6 hours)
Unit ANS4: The biology of agricultural animals (26 hours)
Unit ANS5: Genetics and reproduction (22 hours)
Unit ANS6: Nutrition and feeding of agricultural animals (24 hours)
Unit ANS7: Health of agricultural animals (24 hours)
Unit ANS8: Animal production (20 hours)
Unit ANS9: Exhibiting animals (14 hours)
Unit ANS10: Animal biotechnology (10 hours)
Unit ANS11: Agricultural education (10 hours)

Horticulture / Botany (*Select all that apply*)

Unit IHO1: Importance and use of horticultural plants and products (14 hours)
Unit IHO2: Career entry and advancement in horticulture industries (6 hours)
Unit IHO3: Horticulture safety (5 hours)
Unit IHO4: Sustainable horticulture production (15 hours)
Unit IHO5: Plant biology (30 hours)
Unit IHO6: Plant growth (30 hours)
Unit IHO7: Soil science and media (26 hours)
Unit IHO8: Plant propagation (14 hours)
Unit IHO9: Plant cultural practices (30 hours)
Unit IHO10: Agricultural education (10 hours)

3. Identify the instructional topic(s) that most closely relate to the ones you instructed during this reporting period.

Plant and Soil Science (*Select all that apply*)

Benchmark PLS1–1: Students will discuss the importance of plants in meeting human needs.
Benchmark PLS1–2: Students will list and describe major kinds of plants in the local community, state, nation, and globally.
Benchmark PLS1–3: Students will explain plant domestication and identify important local domesticated plants.
Benchmark PLS1–4: Students will identify the roles of technology, including biotechnology, in plant science.
Benchmark PLS1–5: Students will compare and contrast organic production of crops.
Benchmark PLS1–6: Students will explain the practices in food crop production that promote food safety.
Benchmark PLS2–1: Students will identify occupations in plant– and soils–related industries and the competencies needed for occupational entry.
Benchmark PLS2–2: Students will name and describe important interpersonal skills for success in plant– and soil–related careers.
Benchmark PLS3–1: Students will assess safety situations with plants and soils and choose appropriate safety practices.

Benchmark PLS3–2: Students will properly select, use, and maintain personal protective equipment when working with plants and soil.
Benchmark PLS4–1: Students will explain the meaning and importance of sustainable plant production.
Benchmark PLS4–2: Students will discuss the meaning and use of resource conservation in plant production.
Benchmark PLS4–3: Students will identify and explain the use of technology in sustainable plant production.
Benchmark PLS5–1: Students will explain plant life cycles and classify important plants by life cycle.
Benchmark PLS5–2: Students will identify and explain the functions of the major vegetative parts of plants.
Benchmark PLS5–3: Students will distinguish between sexual and asexual reproduction of plants.
Benchmark PLS5–4: Students will identify and explain the functions of major reproductive parts of plants.
Benchmark PLS5–5: Students will explain the importance of seed in plant reproduction.
Benchmark PLS5–6: Students will name and explain important methods of asexual plant propagation.
Benchmark PLS5–7: Students will discuss the importance of plant genetics and breeding.
Benchmark PLS6–1: Students will discuss the cellular structure of plants.
Benchmark PLS6–2: Students will discuss processes in plant growth.
Benchmark PLS6–3: Students will identify the role of hormones in plant growth and development.
Benchmark PLS6–4: Students will explain the meaning and importance of photosynthesis.
Benchmark PLS6–5: Students will name the nutrients needed for plant growth and development and describe the functions of major nutrients.
Benchmark PLS7–1: Students will discuss the meaning and importance of soil.
Benchmark PLS7–2: Students will identify the constituents of soil and relationship of constituents to soil texture.
Benchmark PLS7–3: Students will describe how soil is formed and relate the role of soil horizons.
Benchmark PLS7–4: Students will explain soil fertility and its relationship to plant productivity.
Benchmark PLS7–5: Students will explain soil pH and identify ways of modifying pH.
Benchmark PLS7–6: Students will discuss nutrient diagnostic procedures and make a soil sample.
Benchmark PLS7–7: Students will relate the meaning and importance of land and its classification.
Benchmark PLS7–8: Students will explain the meaning and types of soil erosion and discuss methods of reducing soil erosion.
Benchmark PLS8–1: Students will identify cultural conditions essential for plant productivity and food safety.
Benchmark PLS8–2: Students will distinguish between traditional and minimum tillage practices.
Benchmark PLS8–3: Students will explain the meaning and use of fertilizers and soil amendments.
Benchmark PLS8–4: Students will explain the meaning and use of integrated pest management.

Benchmark PLS8–5: Students will explain the meaning and use of irrigation.
Benchmark PLS9–1: Students will manage an appropriate supervised experience in plant and soil science.
Benchmark PLS9–2: Students will identify opportunities for participation and advancement in the FFA related to plant and soil science.

## Animal Science (*Select all that apply*)

Benchmark ANS1–1: Students will discuss three areas of agricultural animals, including animal production, animal supplies and services, and marketing and processing.
Benchmark ANS1–2: Students will describe the scope and importance of agricultural animals to Oklahoma and the United States.
Benchmark ANS1–3: Students will list and explain ways animals and the products provided by animals help people.
Benchmark ANS1–4: Students will name common agricultural animals and identify their products and uses.
Benchmark ANS1–5: Students will explain the importance and practice of animal well–being and ethics.
Benchmark ANS2–1: Students will identify occupations in the animal industry and list the competencies needed for occupational entry.
Benchmark ANS2–2: Students will name and describe important personal skills for success in the animal industry.
Benchmark ANS2–3: Students will identify education and training needs for occupations in animal agriculture.
Benchmark ANS3–1: Students will assess personal and occupational safety situations in animal science work and choose appropriate safety practices
Benchmark ANS3–2: Students will properly select, use, and maintain personal protective equipment when working in animal science.
Benchmark ANS4–1: Students will identify agricultural animals by common and scientific names.
Benchmark ANS4–2: Students will classify agricultural animals using scientific classifications and as birds, aquatic animals, mammals, and others.
Benchmark ANS4–3: Students will name and explain the life needs of agricultural animals.
Benchmark ANS4–4: Students will identify major anatomical features of animals and explain differences among species.
Benchmark ANS4–5: Students will describe the major physiological features of animals, including body systems and their functions.
Benchmark ANS4–6: Students will identify sexual and age classifications of species of agricultural animals.
Benchmark ANS5–1: Students will explain the importance of genetics and heredity in animal science.
Benchmark ANS5–2: Students will define reproduction and describe the process of sexual reproduction in animals, including birds, fish, and mammals.
Benchmark ANS5–3: Students will explain the role of breeding in animal improvement and relate breeding to animal selection.
Benchmark ANS5–4: Students will define artificial insemination and explain its importance in animal agriculture.
Benchmark ANS5–5: Students will identify major reproductive organs and distinguish between male and female reproductive systems and processes.
Benchmark ANS5–6: Students will define and explain phases of reproductive

development in mammals, including puberty, fertilization, gestation, parturition, and lactation.
Benchmark ANS5–7: Students will demonstrate the application of breeding animal evaluation, including performance testing, production records, progeny testing, and visual appraisal.
Benchmark ANS6–1: Students will explain the meaning and importance of nutrition with agricultural animals.
Benchmark ANS6–2: Students will list the nutrient needs of animals and explain the functions of each nutrient.
Benchmark ANS6–3: Students will contrast and compare digestive systems found in agricultural animals, including ruminant and non ruminant systems.
Benchmark ANS6–4: Students will name and explain the roles of nutrients with animals, including maintenance, growth, reproduction, lactation, and work.
Benchmark ANS6–5: Students will name the kinds of feedstuffs and classify as roughage, concentrate, and supplement.
Benchmark ANS6–6: Students will interpret feed analysis information on a label.
Benchmark ANS6–7: Students will list ways animals are fed and demonstrate the use of an appropriate feeding method.
Benchmark ANS6–8: Students will explain the meaning of balanced ration and indicate ways of balancing a ration.
Benchmark ANS7–1: Students will explain the meaning of animal health and describe signs of good health and disease and apply the signs in assessing animals.
Benchmark ANS7–2: Students will identify factors in the environment related to the health of animals.
Benchmark ANS7–3: Students will name common diseases of agricultural animals, list the symptoms, and classify the diseases as contagious, nutritional, physiological, morphological, and genetic.
Benchmark ANS7–4: Students will identify practices that promote good health among agricultural animals.
Benchmark ANS7–5: Students will name ways of treating diseases and parasites and demonstrate how to administer medications.
Benchmark ANS7–6: Students will describe the proper use of pharmaceuticals in the livestock industry.
Benchmark ANS8–1: Students will identify animal species with productive potential in the local community, including market opportunity and profitability.
Benchmark ANS8–2: Students will identify land, facility, and skill needs for animal production.
Benchmark ANS8–3: Students will describe general production practices followed with agricultural animals, including beef animals, dairy, swine, and horses.
Benchmark ANS8–4: Students will explain methods of animal and premises identification.
Benchmark ANS8–5: Students will evaluate methods of animal waste disposal and select an appropriate method for a specific animal production enterprise.
Benchmark ANS9–1: Students will discuss the role and importance of animal exhibits and shows.
Benchmark ANS9–2: Students will explain the selection of animals for showing.
Benchmark ANS9–3: Students will describe the care and practices in raising a show animal.
Benchmark ANS9–4: Students will demonstrate practices in halter breaking, grooming, and show ring management of an animal.
Benchmark ANS9–5: Students will explain and demonstrate ethics associated with

showing livestock.
Benchmark ANS10–1: Students will define biotechnology and name examples with agricultural animals.
Benchmark ANS10–2: Students will explain the meaning of genetic engineering of animals and identify issues associated with this technology.
Benchmark ANS10–3: Students will explain the role of DNA in genetic engineering and demonstrate the extraction of DNA from animal cells.
Benchmark ANS11–1: Students will manage an appropriate supervised experience in animal science.
Benchmark ANS11–2: Students will identify opportunities for participation and advancement in the FFA related to agricultural animals.

## Horticulture / Botany (*Select all that apply*)

Benchmark IHO1–1: Students will discuss the importance of horticulture plants.
Benchmark IHO1–2: Students will list and describe major areas of the horticulture industry.
Benchmark IHO1–3: Students will relate plant domestication to horticulture.
Benchmark IHO1–4: Students will identify the roles of technology, including biotechnology, in horticulture.
Benchmark IHO1–5: Students will explain hydroponics and describe how it is practiced in horticulture production.
Benchmark IHO2–1: Students will identify occupations in horticulture industries and the competencies needed for occupational entry.
Benchmark IHO2–2: Students will name and describe important interpersonal skills for success in horticulture careers.
Benchmark IHO3–1: Students will assess safety situations in horticulture work and choose appropriate safety practices.
Benchmark IHO3–2: Students will properly select, use, and maintain personal protective equipment when working in horticulture.
Benchmark IHO4–1: Students will explain the meaning and importance of sustainable horticulture production.
Benchmark IHO4–2: Students will discuss the meaning and use of resource conservation in horticulture production.
Benchmark IHO4–3: Students will compare and contrast organic methods of production with traditional methods.
Benchmark IHO4–4: Students will identify common annual, biennial, and perennial horticultural plants in the local area.
Benchmark IHO5–1: Students will explain plant life cycles and classify important plants by life cycle.
Benchmark IHO5–2: Students will identify and explain the functions of the major vegetative parts of plants.
Benchmark IHO5–3: Students will distinguish between sexual and asexual reproduction of plants.
Benchmark IHO5–4: Students will identify and explain the functions of major reproductive parts of plants.
Benchmark IHO5–5: Students will explain the importance of seed in plant reproduction.
Benchmark IHO5–6: Students will name and explain important methods of asexual plant propagation.

Benchmark IHO5–7: Students will discuss the importance of plant genetics and breeding.
Benchmark IHO6–1: Students will discuss the cellular structure of plants.
Benchmark IHO6–2: Students will discuss processes in plant growth.
Benchmark IHO6–3: Students will identify the role of hormones in plant growth and development.
Benchmark IHO6–4: Students will explain the meaning and importance of photosynthesis and respiration.
Benchmark IHO6–5: Students will name the nutrients needed for plant growth and development and describe the functions of major nutrients.
Benchmark IHO7–1: Students will discuss the meaning and importance of soil.
Benchmark IHO7–2: Students will identify the constituents of soil and relationship to soil texture.
Benchmark IHO7–3: Students will describe how soil is formed.
Benchmark IHO7–4: Students will explain soil fertility and relationship to plant productivity.
Benchmark IHO7–5: Students will explain soil pH and identify ways of modifying pH.
Benchmark IHO7–6: Students will discuss nutrient diagnostic procedures and make a soil sample.
Benchmark IHO7–7: Students will relate the meaning and importance of land and its classification.
Benchmark IHO7–8: Students will explain the qualities of good media and prepare media to use with particular crops.
Benchmark IHO8–1: Students will explain the sexual propagation of plants and identify conditions essential for seed germination.
Benchmark IHO8–2: Students will demonstrate the sexual propagation of selected horticultural plants.
Benchmark IHO8–3: Students will demonstrate the use of bulbs, corms, and tubers in the propagation of selected plants.
Benchmark IHO8–4: Students will explain the meaning and use of asexual propagation with selected crops.
Benchmark IHO9–1: Students will identify cultural conditions essential for plant productivity.
Benchmark IHO9–2: Students will explain the meaning and use of fertilizers and soil amendments.
Benchmark IHO9–3: Students will explain the meaning and use of integrated pest management.
Benchmark IHO9–4: Students will explain the meaning and use of irrigation in horticultural crop production.
Benchmark IHO9–5: Students will identify the requirements for chemical applicator certification in horticulture.
Benchmark IHO9–6: Students will demonstrate skills in culturing a horticultural crop.
Benchmark IHO10–1: Students will manage an appropriate supervised experience in horticulture.
Benchmark IHO10–2: Students will identify opportunities for participation and advancement in the FFA related to horticulture.

4. Identify the following curriculum sources that you consulted for the development of your instructional lessons: (*Select all that apply*)

CAERT Curriculum Lesson Plans
CAERT Curriculum Print/Electronic teacher resources
CAERT Curriculum PowerPoint® Files
CAERT Instructional E–Units
CAERT Course Benchmark aligned questions
CIMC Curriculum Lesson Plans
CIMC Curriculum Print/Electronic teacher resources
CIMC Curriculum PowerPoint® files
CIMC Curriculum Video resources
CIMC Curriculum aligned question resources
CEV Curriculum Lesson Plans
CEV Curriculum Print/Electronic teacher resources
CEV Curriculum PowerPoint® files
CEV Curriculum Video resources
CEV Curriculum aligned question resources
Thompson Delmar Publishing
Interstate Publishers
Pearson Prentice Hall
Other *(Please list)* ____________________

5. Check the following instruction types that you used during this reporting period: (*Select all that apply*)

| | | |
|---|---|---|
| □ Lecture | □ Lecture with discussion | □ Teacher questioning |
| □ Teacher demonstration | □ Teacher problem modeling | □ Small group discussion/activity |
| □ Student led discussion/activity | □ Class discussion | □ Hands–on; experiential activity |
| □ Independent student work | □ Use of computers, calculators, or other technology | □ Cooperative learning activity |

| | | |
|---|---|---|
| □ Laboratory activity | □ Work sheet work/writing | □ Use of text, reading materials |
| □ Teacher interaction with individual students | □ Assessment of student learning | □ Review of assignments/tests/projects |
| □ Assign homework | □ Out of classroom (field experience, shop, greenhouse, etc. | |

(*Parr, 2004 p. 184)

APPENDIX E

TREATMENT TEACHER GROUP QUALITATIVE INTERVIEW

**Department of Agricultural Education, Communications and Leadership**

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*Experimental Teacher Group Qualitative Interview*

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1. Describe what you liked about the CAERT curriculum.
2. How did the CAERT curriculum allow you to become a more effective instructor?
3. How could the CAERT curriculum be improved?
4. How did you sense student engagement to be during the use of the CAERT curriculum?
5. What do you perceive to be the barriers that are associated with the use of the CAERT curriculum?
6. What do you perceive to be the advantages to using the CAERT curriculum?
7. What do you perceive to be some weaknesses of the CAERT curriculum?
8. What do you perceive as being the level of rigor in the CAERT curriculum?
9. Describe the science content within the CAERT curriculum as compared to other curriculums that you may have used.
10. What lessons do you feel that the students struggled with the most in the CAERT curriculum?
11. Which lessons do you feel where the easiest to teach in the CAERT curriculum?
12. Considering your normal instructional week, explain how often you used the CAERT curriculum?

# APPENDIX F

# TREATMENT GROUP TEACHERS QUALITATIVE INTERVIEW RESPONSES

**Department of Agricultural Education, Communications and Leadership**

*Teacher Qualitative Interview*

1. Describe what you liked about the CAERT curriculum. The text book style was easy to read and the students liked it.
2. How did the CAERT curriculum allow you to become a more effective instructor? I liked that it was on line because students seem to think that every thing come from the internet these days and it make it more fun for them, as well as, I think, it fits their current learning style.
3. How could the CAERT curriculum be improved? The power points were terrible. (no sugar coating) I would have students tell me that they could develop better power points than the ones on line. I would spend 2-3 hours improving the power points for each section that I taught. That became tiresome so I quit using the power points. I could not figure out how to use the test banks. The two times that I tried to use the test banks they were cumbersome and not easy to use. I developed my own test.
4. How did you sense student engagement to be during the use of the CAERT curriculum? The students enjoyed using the curriculum except for the power points. Too much information was crammed into each slide and they were not interactive like they were used to seeing. Such as you could see that parts of the

stem with out the answers talk about the parts then the answer appear. They like using this as study guides for quizzes and test. All of the parts of the stem with the parts name appeared at one time.

5. What do you perceive to be the barriers that are associated with the use of the CAERT curriculum? It would be nice if the students had a way to down load the curriculum to take home on a lap top. Too many of my students have internet at home for their use. Many of my students do not have high speed internet if they have internet connections at home. I just came from a meeting of our technology staff and we have passed a bond issue to provide each student at your new high school, opening 2011-2012 school year, with laptops for each student to take home that has their text books loaded on them.
6. What do you perceive to be the advantages to using the CAERT curriculum? If loaded on a laptop portability. I like that since it is electronic information, instead of printed, information updates and new technologies can be updated faster so the students are getting the newest and latest information. This will be the norm in their world.
7. What do you perceive to be some weaknesses of the CAERT curriculum? Power points and test banks. I could not even determine it I could choose questions of it they were set. I did talk to other teachers and they were having similar problems.
8. What do you perceive as being the level of rigor in the CAERT curriculum? I feel that the rigor is great. For the most part it challenged my students without presenting concepts that were too difficult for them to grasp.

9. Describe the science content within the CAERT curriculum as compared to other curriculums that you may have used. This curriculum is similar to other curriculum that I have used; the main difference is how it is delivered.
10. What lessons do you feel that the students struggled with the most in the CAERT curriculum? There was not a particular area that all of them struggled in.
11. Which lessons do you feel where the easiest to teach in the CAERT curriculum? I can not remember which one the students picked up the best.
12. Considering your normal instructional week, explain how often you used the CAERT curriculum? When I was teaching the plant science part I used the curriculum at least four days a week.

**Department of Agricultural Education, Communications and Leadership**

*Teacher Qualitative Interview*

1. Describe what you liked about the CAERT curriculum.

   *I enjoyed that the lessons were prepared ahead of time, and little work was needed to get ready for the lesson. It included good handouts and worksheets for the students and was much easier than relying on a text book or another form of curriculum. Also, there were a wide variety of lessons to choose from.*

2. How did the CAERT curriculum allow you to become a more effective instructor?

   *Again, I had lessons that were prepared for me and I always had something to teach when I walked into the classroom. The lessons were complete and contained a wide variety of science-based information.*

3. How could the CAERT curriculum be improved?

   *I believe the Plant science curriculum was not necessarily the type of lessons I use in my horticulture classes. We focus a lot on floral design and landscaping, and these lessons did not include that curriculum. Also, I believe many of the lessons would need to be taught at a lower science level for many teachers and students to better understand them. One major change I would like to see would be a test and key at the end of each chapter with 25-50 questions.*

4. How did you sense student engagement to be during the use of the CAERT curriculum?

   *Some of the lessons contained interesting information that really engaged students. However, some of the material was way over their heads, and they gave up on understanding it.*

5. What do you perceive to be the barriers that are associated with the use of the CAERT curriculum?

   *I think the main barrier is the fact that it is online, and when our school servers are down, it is very frustrating. Also, most of our ag teachers are not technological savvy and will have problems accessing the correct stuff. However, if we all had adequate training in a computer facility where we could actually be shown all the extra things on the program, that would help!*

6. What do you perceive to be the advantages to using the CAERT curriculum?

   *Many lessons at an affordable price.*

7. What do you perceive to be some weaknesses of the CAERT curriculum?

   *Being online with older instructors who main not be able to access it.*

8. What do you perceive as being the level of rigor in the CAERT curriculum?

   *Not sure!*

9. Describe the science content within the CAERT curriculum as compared to other curriculums that you may have used.

   *CAERT had much more science curriculum than others. Was more plant science than horticulture, and would definitely meet many science PASS standards.*

10. What lessons do you feel that the students struggled with the most in the CAERT curriculum? *Biotechnology, genetics…*

11. Which lessons do you feel where the easiest to teach in the CAERT curriculum?

    *Parts of the flower, parts of the plant, roots, etc.*

12. Considering your normal instructional week, explain how often you used the CAERT curriculum?

    *I used it the first 2 months of the class, about 3-4 days per week. Then I used different curriculum, and came back to it about 3 days per week during the $3^{rd}$ 9 weeks of class.*

# APPENDIX G

# INSTITUTIONAL REVIEW BOARD APPROVAL

## Oklahoma State University Institutional Review Board

| | |
|---|---|
| Date: | Tuesday, January 26, 2010 |
| IRB Application No | AG103 |
| Proposal Title: | Testing the Impact of a Science-Enhanced Curriculum on the Science Achievement and Agricultural Competency of Secondary Agricultural Education Students |
| Reviewed and Processed as: | Exempt |

**Status Recommended by Reviewer(s): Approved Protocol Expires: 1/25/2011**

Principal Investigator(s):

James C. Haynes
444 Ag Hall
Stillwater, OK 74078

Shane Robinson
440 Ag Hall
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Shelia Kennison, Chair
Institutional Review Board

APPENDIX H

SCHOOL PRINCIPAL CONSENT FORM TREATMENT GROUP

**Science-Enhanced Curriculum Research Study**
**School Principal Consent Form**
**Treatment Group**

January 2010

__________________ has agreed to participate in a joint research study between the Oklahoma Department of Career and Technology Education (ODCTE) and the Agricultural Education, Communications and Leadership department at Oklahoma State University (OSU). This teacher was randomly selected from a pool of science certified instructors in the state and recommendations of teaching excellence made by ODCTE state staff. We ask that you sign this letter of consent indicating that you are informed about the study and support the teachers' participation in this project.

**Background Information:**

The purpose of this study is to determine if science-enhanced curriculum taught in a secondary level animal or plant science course will significantly improve students' understanding of selected scientific principles when compared to students who were instructed using a traditional curriculum. Additionally this study will seek to determine what impact a science-enhanced curriculum has on students' agricultural content knowledge.

**Procedures:**

- Provide classroom instruction for the selected course using the curriculum and teaching resources provided by the Center for Agricultural and Environmental Research and Training (CAERT).
- Administer a science examination provided by the National Research Center for Career and Technical Education (NRCCTE) to four randomly selected participants in the teachers('s)selected course.
- Administer an agricultural education subject area competency test that will be provided by the Oklahoma Department of Career and Technology Education (ODCTE).
- Provide web-based weekly reports over the teachers('s)instruction.

**Risks and Benefits:**

There are no known risks associated with this study that would occur as a result of participation. Perceived benefits include the knowledge that a potential science-enhanced curriculum exists that would allow for the better diffusion of science education through the context of agricultural education.

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IRB
Approved 1/26/10
Expires 1/25/11
IRB# AG-10-3

**Confidentiality:**

Your school can be assured that the records of this study will be kept private and any information obtained relating to you or your students will be kept confidential. Any reports that are generated as a result of this study will remain confidential as well, and not include any identifiers to you or your students. Since this is a joint collaboration between Oklahoma State University and the ODCTE, a confidential report will be given to the ODCTE outlining the results. Since this is classified as a voluntary study, your decision to participate will have no bearing on your current or future relationship with OSU.

**Contact Information:**

If you have any questions now or in the future regarding this study, please do not hesitate to contact myself or the others listed below.


| J. Chris Haynes | Kurt Murray | Dr. Shane Robinson |
|---|---|---|
| 405-744-3036 | 405-744-3036 | 405-744-3094 |
| chris.haynes@okstate.edu | kmurr@okcareertech.org | shane.robinson@okstate.edu |


If you have questions about your rights as a research volunteer, you may contact the Oklahoma State University Institutional Review Board (IRB) Chair, Dr. Shelia Kennison at 219 Cordell North, Stillwater, OK 74078, 405-744-3377 or irb@okstate.edu.

Please retain a copy of this form for your records

**Statement of Consent:**

I have read the above information and support the participation of the teacher in this study.

Printed Name ____________ Signature ____________ Date ____________

# APPENDIX I

## SCHOOL PRINCIPAL CONSENT FORM COMPARISON GROUP

**Science-Enhanced Curriculum Research Study**
**School Principal Consent Form**
**Control Group**

January 2010

____________________ has agreed to participate in a joint research study between the Oklahoma Department of Career and Technology Education (ODCTE) and the Agricultural Education, Communications and Leadership department at Oklahoma State University (OSU). This teacher was randomly selected from a pool of science certified instructors in the state and recommendations of teaching excellence made by ODCTE state staff. We ask that you sign this letter of consent indicating that you are informed about the study and support the teachers' participation in this project.

**Background Information:**

The purpose of this study is to determine if science-enhanced curriculum taught in a secondary level animal or plant science course will significantly improve students' understanding of selected scientific principles when compared to students who were instructed using a traditional curriculum. Additionally this study will seek to determine what impact a science-enhanced curriculum has on students' agricultural content knowledge.

**Procedures:** The following requirements have been identified as crucial to this study.

The teacher will:

- Provide classroom instruction for the selected course using the curriculum and teaching methods that the teachers('s)would normally use.
- Administer a science examination provided by the National Research Center for Career and Technical Education (NRCCTE) to four randomly selected participants in the teachers('s)selected course.
- Administer an agricultural education subject area competency test that will be provided by the Oklahoma Department of Career and Technology Education (ODCTE).
- Provide web-based weekly reports over the teachers('s) instruction.

**Risks and Benefits:**

There are no known risks associated with this study that would occur as a result of participation. Perceived benefits include the knowledge that a potential science-

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IRB# AG-10-3

enhanced curriculum exists that would allow for the better diffusion of science education through the context of agricultural education.

**Confidentiality:**

Your school can be assured that the records of this study will be kept private and any information obtained relating to you or your students will be kept confidential. Any reports that are generated as a result of this study will remain confidential as well, and not include any identifiers to you or your students. Since this is a joint collaboration between Oklahoma State University and the ODCTE, a confidential report will be given to the ODCTE outlining the results. Since this is classified as a voluntary study, your decision to participate will have no bearing on your current or future relationship with OSU.

**Contact Information:**

If you have any questions now or in the future regarding this study, please do not hesitate to contact myself or the others listed below.


| | | |
|---|---|---|
| J. Chris Haynes | Kurt Murray | Dr. Shane Robinson |
| 405-744-3036 | 405-744-3036 | 405-744-3094 |
| chris.haynes@okstate.edu | kmurr@okcareertech.org | shane.robinson@okstate.edu |


If you have questions about your rights as a research volunteer, you may contact the Oklahoma State University Institutional Review Board (IRB) Chair, Dr. Shelia Kennison at 219 Cordell North, Stillwater, OK 74078, 405-744-3377 or irb@okstate.edu.

Please retain a copy of this form for your records

**Statement of Consent:**

I have read the above information and support the participation of the teacher in this study.

Printed Name ____________________ Signature ____________________ Date __________

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# APPENDIX J

## INSTRUCTOR CONSENT FORM TREATMENT GROUP

**Testing the Impact of a Science-Enhanced Curriculum on the Science Achievement and Agricultural Competency of Secondary Agricultural Education Students**
**Instructor Consent Form**
**Treatment Group**

January 2010

Greetings Oklahoma Ag Ed Instructors,

First off let me begin by saying thank you for agreeing to assist us in this study. It is only with your help and dedication that this research project will be a success. This research project will serve as a joint collaboration of Oklahoma State University (OSU) and the Oklahoma Department of Career and Technology Education (ODCTE) to field test a science-enhanced curriculum for agricultural education provided to ten pilot schools in the state which is expected to last through the spring semester of 2010.

**Background Information:**

The purpose of this study is to determine if science-enhanced curricula taught in a secondary level animal or plant science course will significantly improve students' understanding of selected scientific principles when compared to students who were instructed using a traditional curriculum. Additionally this study will seek to determine what impact a science-enhanced curricula has on students' agricultural content knowledge.

**Procedures:**

- Provide classroom instruction for the selected course using the curriculum and teaching resources provided by the Center for Agricultural and Environmental Research and Training (CAERT).
- Administer a science examination provided by the National Research Center for Career and Technical Education (NRCCTE) randomly selected by the principle investigator for participants in your selected course.
- Administer an agricultural education subject area competency test that will be provided by the Oklahoma Department of Career and Technology Education (ODCTE).
- Provide web-based weekly reports over your instruction.

**Risks and Benefits:**

There are no known risks associated with this study that would occur as a result of participation. Perceived benefits include the knowledge that a potential science-enhanced curricula exists that would allow for the better diffusion of science education through the context of agricultural education.

**Confidentiality:**

You can be assured that the records of this study will be kept private and any information obtained relating to you or your students will be kept confidential. Any reports that are generated as a result of this study will remain confidential as well, and not include any identifiers to you or your students. Since this is a joint collaboration between Oklahoma State University and the Oklahoma Department of Career and Technology Education, a confidential report will be given to the ODCTE outlining the results. Since this is classified as a voluntary study, your decision to participate will have no bearing on your current or future relationship with Oklahoma State University.

**Contact Information:**

If you have any questions now or in the future regarding this study, please do not hesitate to contact myself or the others listed below.

| J. Chris Haynes | Kurt Murray | Dr. Shane Robinson |
| --- | --- | --- |
| 405-744-3036 | 405-744-3036 | 405-744-3094 |
| chris.haynes@okstate.edu | kmurr@okcareertech.org | shane.robinson@okstate.edu |

If you have questions about your rights as a research volunteer, you may contact the Oklahoma State University Institutional Review Board (IRB) Chair, Dr. Shelia Kennison at 219 Cordell North, Stillwater, OK 74078, 405-744-3377 or irb@okstate.edu.

You will be given a copy of this form to keep for your records.

**Statement of Consent:**

I have read the above information and freely consent to participate in this study.

________________ ________________ ________

Printed Name Signature Date

________________ ________________ ________

Principle Investigator Signature Date

# APPENDIX K

# INSTRUCTOR CONSENT FORM COMPARISON GROUP

**Testing the Impact of a Science-Enhanced Curriculum on the Science Achievement and Agricultural Competency of Secondary Agricultural Education Students**
**Instructor Consent Form**
**Control Group**

January 2010

Greetings Oklahoma Ag Ed Instructors,

First off let me begin by saying thank you for agreeing to assist us in this study. It is only with your help and dedication that this research project will be a success. This research project will serve as a joint collaboration of Oklahoma State University (OSU) and the Oklahoma Department of Career and Technology Education (ODCTE) to field test a science-enhanced curriculum for agricultural education provided to ten pilot schools in the state which is expected to last through the spring semester of 2010.

**Background Information:**

The purpose of this study is to determine if science-enhanced curriculum taught in a secondary level animal or plant science course will significantly improve students' understanding of selected scientific principles when compared to students who were instructed using a traditional curriculum. Additionally, this study will determine what impact a science-enhanced curricula has on students' agricultural content knowledge. The following procedures will serve as expectations of you during the course of this study.

**Procedures:**

- Provide classroom instruction for the selected course using the curriculum and teaching methods that you would normally use.
- Administer a science examination provided by the National Research Center for Career and Technical Education (NRCCTE) randomly selected by the principle investigator for participants in your selected course.
- Administer an agricultural education subject area competency test that will be provided by the Oklahoma Department of Career and Technology Education (ODCTE) at the end of the spring semester.
- Provide web-based weekly reports over your instruction throughout the duration of the spring semester.

**Risks and Benefits:**

There are no known risks associated with this study that would occur as a result of participation. Perceived benefits include the knowledge that a potential science-

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enhanced curriculum exists that would allow for the better diffusion of science education through the context of agricultural education.

**Confidentiality:**

You can be assured that the records of this study will be kept private and any information obtained relating to you or your students will be kept confidential. Any reports that are generated as a result of this study will remain confidential as well, and not include any identifiers to you or your students. Since this is a joint collaboration between OSU and the ODCTE, a confidential report will be given to the ODCTE outlining the results. Since this is classified as a voluntary study, your decision to participate will have no bearing on your current or future relationship with OSU or ODCTE.

**Contact Information:**

If you have any questions now or in the future regarding this study, please do not hesitate to contact myself or the others listed below.

| | | |
|---|---|---|
| J. Chris Haynes | Kurt Murray | Dr. Shane Robinson |
| 405-744-3036 | 405-744-3036 | 405-744-3094 |
| chris.haynes@okstate.edu | kmurr@okcareertech.org | shane.robinson@okstate.edu |

If you have questions about your rights as a research volunteer, you may contact the Oklahoma State University Institutional Review Board (IRB) Chair, Dr. Shelia Kennison at 219 Cordell North, Stillwater, OK 74078, 405-744-3377 or irb@okstate.edu.

You will be given a copy of this form to keep for your records.

**Statement of Consent:**

I have read the above information and freely consent to participate in this study.

______________________ ______________________ __________

Printed Name Signature Date

______________________ ______________________ __________

Principle Investigator Signature Date

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Expires 1/25/11
IRB# AG-10-3

APPENDIX L

PARENTAL CONSENT FORM

January, 2010

Dear Parent(s):

Your child's agricultural education class has been selected to participate in a research study to determine the effects that a science-enhanced curriculum has on students' science achievement and agricultural competency in agricultural education.

The goal of our project is to determine if a science-enhanced curriculum will help students achieve higher scores in science. During the course of this project, four randomly chosen students will be administered a science examination. As such, your child may or may not be chosen to participate in the science examination. If selected your child has the option to refuse without penalty. However, even though only four students will be selected for science examination purposes, all students will be administered a technical competency exam in agriculture. The results will only be used for research purposes and will in no way affect your child's outcome in the course. Further, please be advised that no information collected during this research will be released to the school or any other recipient and will be destroyed at the end of the study.

If you prefer that your child not participate in this study, please contact me as soon as possible so arrangements can be made to ensure that your child will be excluded from the study. I can be reached at 405-744-3036 or at chris.haynes@okstate.edu if you have any further questions.

Sincerely,

J. Chris Haynes
Graduate Teaching & Research Associate
Department of Agricultural Education, Communications & Leadership
Oklahoma State University

**Science-Enhanced Curriculum Research Study**

**Parent Consent Form**

Return this form **only** if you **do not** want your student to participate in this research study

Print your student's name______________________________________________

I **DO NOT CONSENT** to have my child participate in science tests or agricultural skills tests for the study of science-enhanced curriculum being conducted by researchers from Oklahoma State University.

| ______________________ | ______________________ | __________ |
|---|---|---|
| Printed Name | Signature | Date |

If you agree to your student's participation, you can discard this form. If you have signed the form to indicate you do not want your student to take part in this study, have your student return the form to his or her teacher.

APPENDIX M

STUDENT PARTICIPATION CONSENT FORM

**Testing the Impact of a Science-Enhanced Curriculum on the Science Achievement and Agricultural Competency of Secondary Agricultural Education**

**Students Participant Consent Form**

**Check one of the following boxes:**

☐ I **consent** to participate in science tests and agricultural skills tests for the study of science-enhanced curriculum being conducted by researchers from Oklahoma State University.

☐ I **do not consent** to participate in science tests and agricultural skills tests for the study of science-enhanced curriculum being conducted by researchers from Oklahoma State University.

| ______________________ | ________________________ | ______ |
|---|---|---|
| Printed Name | Signature | Date |

APPENDIX N

FIDELITY WEEKLY REPORT CORRESPONDANCE EMAIL

Month XX, 2010

Dear

First off, let me begin by saying thank you for agreeing to assist us in this study. It is only with your help and dedication that this research project will be a success. This research project will serve as a joint collaboration of Oklahoma State University (OSU) and the Oklahoma Department of Career and Technology Education (ODCTE) to test the effects of a science-enhanced curriculum in agricultural education. The study is expected to last through the spring semester of 2010.

An essential component of this study includes weekly online reports that allow the researcher to better understand the methods you are using during your instruction. I understand the value of your time and have taken steps to ensure that the report is very simple in nature and will take no more than five minutes to complete.

The weekly report can be found at the following location:

http://survey.okstate.edu/WeeklyReport/

Ideally, the report should be submitted the Monday following the week of reported instruction. The first reporting period began this past week,

[Date]. The weekly report website is online and ready for your use.

We understand that at times you will be out of the office fulfilling the requirements of your position and cannot meet the deadline as requested. This is not a problem. However, when this does occur, please submit the report to me at your earliest convenience.

Once again, **Thank You** for your assistance with this study. It is only through your help that we can provide information to the ODCTE that will better allow them to assess the value potential of this curriculum.

Sincerely,

J. Chris Haynes
Graduate Teaching & Research Associate
Oklahoma State University
Department of Agricultural Education, Communications & Leadership
444 Ag Hall
Stillwater, OK 74078
405-744-3036

# APPENDIX O

## TREATMENT AND COMPARISON GROUP CURRICULUM AND INSTRUCTIONAL PERSONAL CHARACTERISTICS

*Experimental and Comparison Group Curriculum and Instructional Personal characteristics (N = 14)*

| Treatment | School | Course Taught | | | Instruction | |
|---|---|---|---|---|---|---|
| | | P&SS | ANSI | HORT | Minutes | Type |
| | Charles Page | | | 1 | 55 | Regular |
| | Durant | 1 | | | 50 | Regular |
| * | Kingfisher | | | | | |
| | Lexington | | 1 | | 85 | Block |
| * | Mooreland | | | | | |
| | Mustang | | 1 | | 55 | Regular |
| Comparison | | | | | | |
| | Cushing | | | 1 | 45 | Regular |
| * | Comanche | | | | | |
| | Edmond | | 1 | 1 | 45 | Regular |
| | Fletcher | | | 1 | 50 | Regular |
| | Harrah | | 1 | 1 | 85 | Block |
| | Jay | | 1 | | 45 | Regular |
| * | McLoud | | | | | |
| | Waukomis | | 1 | 1 | 45 | Regular |

* *No Weekly Report Submission*

# APPENDIX P

## TREATMENT AND COMPARISON GROUP SELF-REPORTED UNITS OF INSTRUCTION

Self-Reported Units of Instruction Taught by Treatment and Control Group Instructors *(N = 14)*

| School | PLS1 | PLS2 | PLS3 | PLS4 | PLS5 | PLS6 | PLS7 | PLS8 | PLS9 | ANS1 | ANS2 | ANS3 | ANS4 | ANS5 | ANS6 | ANS7 | ANS8 | ANS9 | ANS10 | ANS11 | IHO1 | IHO2 | IHO3 | IHO4 | IHO5 | IHO6 | IHO7 | IHO8 | IHO9 | IHO10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Charles Page High School | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | 2 | 2 | |
| Durant | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| * Kingfisher | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lexington High School | | | | | | | | | | | | | | 1 | | 2 | | | | | | | | | | | | | | |
| * Mooreland | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mustang High School | | | | | | | | | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | | 1 | | | | | | | | | | |
| Control | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cushing | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 | | 2 | |
| * Comanche | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Edmond | | | | | | | | | | 1 | | | | 1 | 1 | 1 | 1 | 3 | 1 | | 3 | 1 | 1 | | 1 | 6 | 1 | 5 | | 1 |
| Fletcher | | | | | | 1 | | 1 | | | | | | | | | | | | | | | | | 2 | 1 | 2 | | | |
| Harrah High School | | | | | | | | | | | | | 4 | 7 | | | | | | | | | | | 1 | 10 | 1 | | | |
| Jay High School | | | | | | | | | | | 1 | 1 | 1 | 1 | 4 | 5 | 4 | 2 | | 1 | | | | | | | | | | |
| * McLoud | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Waukomis High School | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | 1 | | |

* *No Weekly Report Submission*

# APPENDIX Q

# TREATMENT AND COMPARISON GROUP SELF-REPORTED INSTRUCTIONAL TOPICS – PLANT AND SOIL SCIENCE

Self-Reported Instructional Topics Taught by Treatment and Control Group Instructors in Plant and Soil Science (N = 14) *a*

| School | PLS1-1 | PLS1-2 | PLS1-3 | PLS1-4 | PLS1-5 | PLS1-6 | PLS2-1 | PLS2-2 | PLS3-1 | PLS3-2 | PLS4-1 | PLS4-2 | PLS4-3 | PLS5-1 | PLS5-2 | PLS5-3 | PLS5-4 | PLS5-5 | PLS5-6 | PLS5-7 | PLS6-1 | PLS6-2 | PLS6-3 | PLS6-4 | PLS6-5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | | | | | | | | | | | | | | | | | | | | | | | | | |
| Charles Page High School | | | | | | | | | | | | | | | | | | | | | | | | | |
| Durant | | | | | | | | | | | | | | | | | | | | | | 1 | | | |
| * Kingfisher | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lexington High School | | | | | | | | | | | | | | | | | | | | | | | | | |
| * Mooreland | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mustang High School | | | | | | | | | | | | | | | | | | | | | | | | | |
| Control | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cushing | | | | | | | | | | | | | | | | | | | | | | | | | |
| * Comanche | | | | | | | | | | | | | | | | | | | | | | | | | |
| Edmond | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fletcher | | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| Harrah High School | | | | | | | | | | | | | | | | | | | | | | | | | |
| Jay High School | | | | | | | | | | | | | | | | | | | | | | | | | |
| * McLoud | | | | | | | | | | | | | | | | | | | | | | | | | |
| Waukomis High School | | | | | | | | | | | | | | | | | | | | | | | | | |

* *No Weekly Report Submission*

Self-Reported Instructional Topics Taught by Treatment and Control Group Instructors in Plant and Soil Science (N = 14) *b*

| | School | PLS7-1 | PLS7-2 | PLS7-3 | PLS7-4 | PLS7-5 | PLS7-6 | PLS7-7 | PLS7-8 | PLS8-1 | PLS8-2 | PLS8-3 | PLS8-4 | PLS8-5 | PLS9-1 | PLS9-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Treatment | | | | | | | | | | | | | | | |
| | Charles Page High School | | | | | | | | | | | | | | | |
| | Durant | | | | | | | | | | | | | | | |
| * | Kingfisher | | | | | | | | | | | | | | | |
| | Lexington High School | | | | | | | | | | | | | | | |
| * | Mooreland | | | | | | | | | | | | | | | |
| | Mustang High School | | | | | | | | | | | | | | | |
| | Control | | | | | | | | | | | | | | | |
| | Cushing | | | | | | | | | | | | | | | |
| * | Comanche | | | | | | | | | | | | | | | |
| | Edmond | | | | | | | | | | | | | | | |
| | Fletcher | | | | | | | | | | | 1 | | | | |
| | Harrah High School | | | | | | | | | | | | | | | |
| | Jay High School | | | | | | | | | | | | | | | |
| * | McLoud | | | | | | | | | | | | | | | |
| | Waukomis High School | | | | | | | | | | | | | | | |

* *No Weekly Report Submission*

# APPENDIX R

# TREATMENT AND COMPARISON GROUP SELF-REPORTED INSTRUCTIONAL TOPICS – ANIMAL SCIENCE

Self-Reported Instructional Topics Taught by Treatment and Control Group Instructors in Animal Science (N = 14) *a*

| | School | ANS1-1 | ANS1-2 | ANS1-3 | ANS1-4 | ANS1-5 | ANS2-1 | ANS2-2 | ANS2-3 | ANS3-1 | ANS3-2 | ANS4-1 | ANS4-2 | ANS4-3 | ANS4-4 | ANS4-5 | ANS4-6 | ANS5-1 | ANS5-2 | ANS5-3 | ANS5-4 | ANS5-5 | ANS5-6 | ANS5-7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Treatment | | | | | | | | | | | | | | | | | | | | | | | |
| | Charles Page High School | | | | | | | | | | | | | | | | | | | | | | | |
| | Durant | | | | | | | | | | | | | | | | | | | | | | | |
| * | Kingfisher | | | | | | | | | | | | | | | | | | | | | | | |
| | Lexington High School | | | | | | | | | | | | | | | | | | 1 | | | | 1 | |
| * | Mooreland | | | | | | | | | | | | | | | | | | | | | | | |
| | Mustang High School | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 |
| | Control | | | | | | | | | | | | | | | | | | | | | | | |
| | Cushing | | | | | | | | | | | | | | | | | | | | | | | |
| * | Comanche | | | | | | | | | | | | | | | | | | | | | | | |
| | Edmond | 2 | | | | | | 1 | 1 | | 1 | | | | | | | | 1 | | | | | |
| | Fletcher | | | | | | | | | | | | | | | | | | | | | | | |
| | Harrah High School | | | | | | | | | | | | | | | | | | | 2 | 2 | 1 | | |
| | Jay High School | 1 | | | 2 | 1 | 1 | 1 | 1 | | 1 | 1 | | 1 | | 2 | 1 | 1 | | 3 | 3 | 1 | | 3 |
| * | McLoud | | | | | | | | | | | | | | | | | | | | | | | |
| | Waukomis High School | | | | | | | | | | | | | | | | | 1 | | | | | | |

* *No Weekly Report Submission*

Self-Reported Instructional Topics Taught by Treatment and Control Group Instructors in Animal Science (N = 14) *b*

| School | ANS6-1 | ANS6-2 | ANS6-3 | ANS6-4 | ANS6-5 | ANS6-6 | ANS6-7 | ANS6-8 | ANS7-1 | ANS7-2 | ANS7-3 | ANS7-4 | ANS7-5 | ANS7-6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | | | | | | | | | | | | | | |
| Charles Page High School | | | | | | | | | | | | | | |
| Durant | | | | | | | | | | | | | | |
| * Kingfisher | | | | | | | | | | | | | | |
| Lexington High School | | | | | | | | | 1 | 1 | | 1 | 1 | |
| * Mooreland | | | | | | | | | | | | | | |
| Mustang High School | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Control | | | | | | | | | | | | | | |
| Cushing | | | | | | | | | | | | | | |
| * Comanche | | | | | | | | | | | | | | |
| Edmond | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | 1 | | | | |
| Fletcher | | | | | | | | | | | | | | |
| Harrah High School | | | | | 2 | 4 | 2 | 1 | 1 | 1 | 1 | | | |
| Jay High School | 3 | 1 | | | 1 | | 1 | 1 | 3 | 3 | 2 | 4 | 3 | 1 |
| * McLoud | | | | | | | | | | | | | | |
| Waukomis High School | | | | | | | | | | | | | | |

* *No Weekly Report Submission*

Self-Reported Instructional Topics Taught by Treatment and Control Group Instructors in Animal Science (N = 14) *c*

| | School | ANS8-1 | ANS8-2 | ANS8-3 | ANS8-4 | ANS8-5 | ANS9-1 | ANS9-2 | ANS9-3 | ANS9-4 | ANS9-5 | ANS10-1 | ANS10-2 | ANS10-3 | ANS11-1 | ANS11-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Treatment | | | | | | | | | | | | | | | |
| | Charles Page High School | | | | | | | | | | | | | | | |
| | Durant | | | | | | | | | | | | | | | |
| * | Kingfisher | | | | | | | | | | | | | | | |
| | Lexington High School | | | | | | | | | | | | | | | |
| * | Mooreland | | | | | | | | | | | | | | | |
| | Mustang High School | 1 | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 |
| | Control | | | | | | | | | | | | | | | |
| | Cushing | | | | | | | | | | | | | | | |
| * | Comanche | | | | | | | | | | | | | | | |
| | Edmond | | | | 1 | | | 2 | 1 | | 1 | | | 1 | | |
| | Fletcher | | | | | | | | | | | | | | | |
| | Harrah High School | | | | | | | | | | | | | | | |
| | Jay High School | | | 1 | 1 | | 2 | 3 | 4 | 3 | 2 | | | | | 1 |
| * | McLoud | | | | | | | | | | | | | | | |
| | Waukomis High School | | | | | | | | | | | | | | | |

* *No Weekly Report Submission*

# APPENDIX S

# TREATMENT AND COMPARISON GROUP SELF-REPORTED INSTRUCTIONAL TOPICS – HORTICULTURE

Self-Reported Instructional Topics Taught by Treatment and Control Group Instructors in Horticulture (N = 14) *a*

| School | IHO1-1 | IHO1-2 | IHO1-3 | IHO1-4 | IHO1-5 | IHO2-1 | IHO2-2 | IHO3-1 | IHO3-2 | IHO4-1 | IHO4-2 | IHO4-3 | IHO4-4 | IHO5-1 | IHO5-2 | IHO5-3 | IHO5-4 | IHO5-5 | IHO5-6 | IHO5-7 | IHO6-1 | IHO6-2 | IHO6-3 | IHO6-4 | IHO6-5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | | | | | | | | | | | | | | | | | | | | | | | | | |
| Charles Page High School | | | | 1 | | | | | | | | | | | | 1 | | 2 | 1 | | | 1 | | | 1 |
| Durant | | | | | | | | | | | | | | | | | | | | | | | | | |
| * Kingfisher | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lexington High School | | | | | | | | | | | | | | | | | | | | | | | | | |
| * Mooreland | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mustang High School | | | | | | | | | | | | | | | | | | | | | | | | | |
| Control | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cushing | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 |
| * Comanche | | | | | | | | | | | | | | | | | | | | | | | | | |
| Edmond | 5 | 1 | 2 | 1 | | 3 | | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | | | 2 | 1 | 2 | 3 |
| Fletcher | | | | | | | | | | 1 | | | | | | | | | | | 1 | 2 | | | 1 |
| Harrah High School | | | | | | | | | | | | | | | | | | | | | | 2 | 2 | 2 | 2 |
| Jay High School | | | | | | | | | | | | | | | | | | | | | | | | | |
| * McLoud | | | | | | | | | | | | | | | | | | | | | | | | | |
| Waukomis High School | | | | | | | | | | | | | | | | | | 1 | | | | | | | |

* *No Weekly Report Submission*

Self-Reported Instructional Topics Taught by Treatment and Control Group Instructors in Horticulture (N = 14) *b*

| School | IHO7-1 | IHO7-2 | IHO7-3 | IHO7-4 | IHO7-5 | IHO7-6 | IHO7-7 | IHO7-8 | IHO8-1 | IHO8-2 | IHO8-3 | IHO8-4 | IHO9-1 | IHO9-2 | IHO9-3 | IHO9-4 | IHO9-5 | IHO9-6 | IHO10-1 | IHO10-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | | | | | | | | | | | | | | | | | | | | |
| Charles Page High School | | | | | | | | | 1 | 1 | | | | | | | | 1 | | 1 |
| Durant | | | | | | | | | | | | | | | | | | | | |
| * Kingfisher | | | | | | | | | | | | | | | | | | | | |
| Lexington High School | | | | | | | | | | | | | | | | | | | | |
| * Mooreland | | | | | | | | | | | | | | | | | | | | |
| Mustang High School | | | | | | | | | | | | | | | | | | | | |
| Control | | | | | | | | | | | | | | | | | | | | |
| Cushing | | | | | | | | | | | | | | | | | | 1 | | 1 |
| * Comanche | | | | | | | | | | | | | | | | | | | | |
| Edmond | | 1 | | 1 | 4 | | | 2 | 1 | 3 | 2 | | | 3 | | | 1 | 3 | 1 | 4 |
| Fletcher | | 1 | 2 | 1 | | 1 | | 1 | | | | | | | | | | 1 | 1 | |
| Harrah High School | 2 | 1 | 1 | 1 | 3 | 4 | 3 | 2 | 1 | | | | | | | | | | | |
| Jay High School | | | | | | | | | | | | | | | | | | | | |
| * McLoud | | | | | | | | | | | | | | | | | | | | |
| Waukomis High School | | | | | | | | | | | | | | | | | | | | |

* *No Weekly Report Submission*

# VITA

James Christopher Haynes

Candidate for the Degree of

Doctor of Philosophy

Dissertation: TESTING THE EFFECT OF A SCIENCE-ENHANCED CURRICULUM ON THE SCIENCE ACHIEVEMENT AND AGRICULTURAL COMPETENCY OF SECONDARY AGRICULTURAL EDUCATION STUDENTS

Major Field: Agricultural Education

Biographical:

Personal Data: Born at San Antonio, Texas on August 29, 1963.
Son of J. D. and Sharon Haynes. Husband of Allison D. Haynes

Education:

Completed the requirements for the Doctor of Philosophy in Agricultural Education at Oklahoma State University, Stillwater, Oklahoma in December, 2010.

Completed the requirements for the Master of Science in Agricultural Education at Tarleton State University, Stephenville, Texas in December 2007.

Completed the requirements for the Bachelor of Science in Agricultural Services and Development at Tarleton State University, Stephenville, Texas in December 1991.

Completed the requirements for the Bachelor of Science in Agriculture/Horticulture Landscape and Design Option at Tarleton State University, Stephenville, Texas in December 1986.
Experience:

Professional Memberships:
American Association for Agricultural Education
Vocational Agriculture Teachers Association of Texas

Name: James Christopher Haynes | Date of Degree: December, 2010

Institution: Oklahoma State University | Location: Stillwater, Oklahoma

Title of Study: TESTING THE EFFECT OF A SCIENCE-ENHANCED CURRICULUM ON THE SCIENCE ACHIEVEMENT AND AGRICULTURAL COMPETENCY OF SECONDARY AGRICULTURAL EDUCATION STUDENTS

Pages in Study: 219 | Candidate for the Degree of Doctor of Philosophy

Major Field: Agricultural Education

Scope and Method of Study: The purpose of this study was to determine if a science-enhanced curriculum produced by the Center for Agricultural and Environmental Research and Training (CAERT) taught in a secondary level animal science or horticulture course would improve students' understanding of selected scientific principles significantly, when compared to students who were instructed using a traditional curriculum. A secondary purpose was to determine the effect that the science-enhanced CAERT curriculum would have on students' agricultural knowledge when compared to students who were instructed using a traditional curriculum. The design of the study was *ex post facto*, causal comparative because no random assignment of the treatment group occurred.

Findings and Conclusions: No statistically significant difference was found between the treatment and comparison groups regarding science achievement. However, the mean score of the treatment group was slightly larger than the comparison group indicating a slightly higher achievement level; a "Small" effect size ($d = .16$) for this difference was calculated. It was determined that a statistically significant difference ($p < .05$) existed in agriculture competency scores in animal science ($p = .001$) and horticulture ($p = .000$) as a result of the treatment. Moreover, this was considered to be a "very large" effect ($d = 1.18$) in animal science and a "large" effect ($d = .92$) in horticulture. When considering student achievement in science, this study found that the use of the science-enhanced CAERT curriculum did not result in a statistically significant increase ($p < .05$) in student performance as determined by the TerraNova[3] science proficiency examination. However, students who were instructed using the CAERT curriculum scored better overall than those who were instructed using a "traditional" curriculum.

ADVISER'S APPROVAL: Dr. J. Shane Robinson