# EVALUATING THE MATHEMATICS ACHIEVEMENT LEVELS OF STUDENTS PARTICIPATING IN THE TEXAS FFA AGRICULTURAL MECHANICS CAREER DEVELOPMENT EVENT

A Dissertation

by

KIRK CLOWE EDNEY

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2009

Major Subject: Agricultural Leadership, Education and Communications

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|---|---|
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December 2009

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# ABSTRACT

Evaluating the Mathematics Achievement Levels of Students
Participating in the Texas FFA Agricultural Mechanics Career Development Event.
(December 2009)
Kirk Clowe Edney, B.S., Texas A&M University;
M.S.T., Tarleton State University
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The purpose of this study was to evaluate the effectiveness of a mathematics enrichment activity used to improve the mathematics performance of students relative to participation in the State Agricultural Mechanics Career Development Event (CDE) and in mandated assessments. The treatment group (13 schools, 43 students) participated in a mathematics enrichment activity situated in an agricultural mechanics context. The control group (16 schools, 56 students) did not participate in the enrichment activity. Both groups, as part of the CDE, were tested with a 100-question word problem examination, completed a individual skill and team activity, and completed a demographic instrument regarding participation in agricultural mechanics CDEs, scholastic performance, use of graphing calculators, enrollment in STEM, agricultural science, and fine arts courses, and other information. After the survey was conducted, schools were asked to provide TAKS exit scores on participating students. These scores were compared between schools and against statewide TAKS scores.

Results of the study showed a significant improvement in scores on the individual written examination and teams scores for the agricultural mechanics CDE and on the TAKS exit level mathematics assessment. Mean written examination scores for the treatment group were 69.53; non-cooperators were 57.16. Mean total team scores for cooperating teams were 420.39; non-cooperators had a mean score of 368.13. Mean TAKS exit level mathematics scores for cooperators were 2336.78; non-cooperators had a mean TAKS exit level score of 2331.77. Participation in the enrichment activity improved both CDE and mathematics achievement scores.

# DEDICATION

This dissertation is dedicated to my family:  to my father, Edward P. Edney, Jr., who wanted me do it; to my mother Patricia Clowe Edney, who knew I could do it; to my wife Regina Edney, who saw me through it, and to our daughter Lauren Edney, who thought that if she could go to college, then her dad could surely do it.

ACKNOWLEDGEMENTS

"The life of service is the life that counts." That phrase from the NFA Creed describes the attitudes of those who have impacted my educational experiences.

I would like to thank my committee chair, Dr. Tim Murphy, and my committee members, Dr. Alvin Larke, Jr., Dr. Jimmy Lindner, and Dr. Patricia Larke for their guidance and support throughout the course of this research.

Dr. Murphy was considerate enough to volunteer to serve as chair for an older guy, with little knowledge of my background or interests. Who would have thought we would have so much in common? You have seen me all the way through this process and have treated my research like it was your own. I am indebted to you for treating me exactly the way I would choose to be treated. You have taken a considerable amount of time away from your family to work with me. That is what Ag teachers do, though. You serve many people in ways that are not always obvious to the casual observer. I am indebted to your wife Mary as well, whom I suspect may have served as a behind the scenes mathematics advisor. Thanks to you both.

Dr. Alvin Larke, Jr. has been my mentor since 1990. When you share your goals with Dr. Larke, watch out! He will continually encourage, and gently chastise, you to meet those goals. We have travelled together several times, and I have always returned home a better person than when I left. Dr. Larke has that effect on people – a visible, and invisible, servant - leader. He lifts me up.

Dr. Jimmy Lindner is the faculty member who shares my interests in graphing calculators and Scouting. Dr. Lindner directed my efforts early on and helped me with much of the foundation for this study. He guided me through the process of getting a paper accepted for NAERC and developing a presentation. He also demonstrates an attitude of service. I wish my dad could have met you. He is about work, hard work.

Dr. Patricia Larke stepped up to serve on my committee when Dr. Lamb felt it was in the best interests of his health to withdraw. You have held my research to the same high standards you held my coursework. You serve many others in unseen ways, and your teaching will continue to change my life for the better.

Dr. Lamb, I am sorry you were unable to help me complete my dissertation process. You partnered with me every Friday night, encouraging me to keep reading and writing. You helped stack my committee with Methodists. Take care and keep serving!

Thanks also go to my friends and colleagues and the ALEC faculty and staff for making my pursuit of a Ph.D. a great experience. No dissertation in ALEC is complete without statistical wisdom from Dr. Briers. Dr. Shinn, Dr. Murphrey, Dr. Dooley and Dr. Elbert, you all shepherded me through the coursework. I would be remiss if I forgot the encouragement and punctuation assistance I received from Dr. Christiansen, not to mention his service as my student teaching supervisor a few years ago.

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My family served me beyond measure. My father, E.P., “Buddy” to his friends and mine, never saw me start this degree, but he wanted it for me just the same. He was quiet, kind and always a gentleman. My mother Patricia was the gentle encourager and firm guide. They showed me the life of service on a daily basis and will have the best view the day I am hooded. You encouraged me through Guion Hall, G. Rollie White Arena, Clyde Wells Auditorium, and now Reed Arena with persistence, faith and love.

My wife of 30 years, Regina didn’t mind where we went as long as we went together. We have been to Adobe Walls, Bright Star, and both Carlisles, but for too long I have camped behind a PC. I don’t know where we will go next, but we will go somewhere. She is ALL about quality teaching, rigor and relevance, and serving her students and community. To our daughter Lauren, who helped me reserve textbooks, get registered online, pick up scantrons, and otherwise navigated me through everything a 50-something college student needs to know. She understands a commitment to service. Take care of the dogs. Much love to you both!

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Life is not complete without in-laws; everyone has them. Bill and Tobbie Alexander, their daughter Kim and her husband Joe Hutcheson, and their children. I'm sure they all think that guy MUST be crazy! You may be right.

I owe a very large thank-you to the 29 Ag teachers and their students at the schools willing to participate in my study. You helped make it happen for me and continue to serve others. Lastly, to the 1800+ Texas Ag teachers and numerous college faculty who work so hard to serve the youth of this state, thank you all. Now it is up to me to take my new knowledge, find new ways to serve, and get busy serving!

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# CHAPTER I

# INTRODUCTION

## BACKGROUND

Agricultural education can provide a model for the integration of mathematics, science and engineering concepts in a real-world context. While integrated teaching occurs in both general and vocational classrooms, it is more likely to be a methodology used in CTE classrooms (Balschweid, Thompson & Cole, 2000). Increased efforts to deliver contextual or situated learning through career and technical education should result in improved student performance and increased levels of permanent learning (Lave & Wenger, 1991). Individuals who are adept at quickly recalling personally significant knowledge are more able to apply that knowledge effectively (Carey, 2008). Participation in competitive activities offered through student organizations has recognized educational value (Reese, 2001). These competitive activities can provide a context to assess knowledge.

The integration of general and workplace education in contextual settings has been a cornerstone of vocational agriculture education since the passage of the Smith-Hughes Act in 1917. The educational philosopher John Dewey, a longtime proponent of unity between vocational and academic education, supported an assessment process that

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This dissertation follows the style of *Journal of Agricultural Education.*

quantified content knowledge, application of knowledge, and knowledge gained from the interaction of work and life. Charles Prosser, also an educator, felt that a dual-track system of general and vocational education offered the most efficient method of curing many social ills such as unemployment, high public school dropout rates, and addressing a shortage of trained workers. Prosser supported the concepts of a dual-track system as identified through the Smith-Hughes Act, and was surprised when Dewey did not support that legislation (Herrick, 1996). Over the last twenty years, many educational reform efforts have focused on curing symptoms whose causes may be partially rooted in the dual-system concept.

For many students, learning mathematics may be accomplished easier in contextual settings. Vocational, or CTE, classrooms offer an excellent opportunity for teaching mathematics in the context of real-life situations. Student learning improves when content is placed in contexts or situations that have personal significance to those learners (Stone, 2005). An emphasis on contextual curriculum has been shown to improve various aspects of student learning by enhancing the connection between subject matter content and real life (National Research Council, 1996).

## Contextualized Instruction

Contextualized instruction is the delivery of curriculum content couched in a scenario, situation, or application that has significant meaning for the learner. Many of today's high school students learn better in context-rich situations. Secondary agricultural mechanics instruction is designed to develop an understanding of the applications of mathematics, reinforce mathematics through situated learning, and provide instruction in employability and entrepreneurial skills through such a context (Shinn, 1998). The benefits of contextual or situated learning are supported by nationally recognized organizations such as the National Council for Teachers of Mathematics (1989), the American Association for the Advancement of Science (1990), and the National Research Council (1990).

In this study, the terms agricultural mechanics and power, structural and technical systems have the same general meaning, and were used interchangeably to provide a broader understanding of the concepts involved in specific curriculum areas. The term power, structural and technical systems identifies a specific pathway associated with the career clusters concept.

School districts provide a wide variety of contexts for learning to occur. Additionally, due to the requirements of mandated high-stakes testing, schools are willing to go to great lengths to improve student performance in core academic subject areas. One particular area in which school districts often seek improvement is mathematics scores. Mathematics scores across the United States continue to need of improvement, as indicated by the latest TIMMS results (McGrath, 2008). Other countries continue to outperform American students in measured areas that correlate to science, technology, and mathematics (STEM) proficiency (Petrinjak, 2008). The National Assessments of Educational Progress, or NAEP examinations, is one of the most commonly referenced achievement benchmarks. These NAEP assessments are given at the 4$^{th}$ and 8$^{th}$ grade levels periodically. Texas 8$^{th}$ grade students ranked 21$^{st}$ in mathematics proficiency and 33rd in science proficiency on the most recent NAEP assessment (Editorial Projects in Education, 2008).

There are a great number of mathematics- and science-improvement initiatives and materials available to schools, such as the Texas Rural Systemic Initiative (TRSI) and Urban Systemic Initiative (National Science Foundation, 1998), Mathematical Modeling with Applications, and Agricultural Algebraic Extensive Exploration ($A^2E^2$). These products and approaches are intended to narrow the performance gap in STEM areas, and improve mathematics scores in low-performing districts. The concept of developing problem-solving skills to improve student achievement is a cornerstone of these systemic reform initiatives (Smith & O'Day, 1990). The effectiveness of these materials and programs varies widely between school districts (Institute of Educational Sciences, 2004). The What Works Clearinghouse of the USDE describes no mathematics interventions as effective at the secondary level.

Authentic Assessment

Authentic assessment is a process of evaluating student performance that involves a real-world context or situation (Wiggins, 1989). One of the tasks of education is to prepare students for the changing workforce of the next century. Students must develop higher-order thinking skills to be successful in the workplace. Employers continue to seek dependable employees who, in addition to other attributes, are competent in basic mathematics. Agriculture can provide the context for many mathematics problems. Engaging students in solving mathematical problems in authentic workday situations should improve their grasp of mathematics and employability options (Derrickson, 2007). Opportunities for authentic performance assessment increase the problem solving skills of students, and develop flexibility and innovativeness (Grady, 1994). Secondary students are under increasing pressure to perform effectively on standardized assessments. They may be at risk of not graduating from high school if they are unable to demonstrate mastery of specific content benchmarks. Authentic assessment is an evaluation model that has generally been supported for use in career-technical education (Elliott, 1991). Johnson (1991) has previously demonstrated the efficacy of linking agricultural mechanics instruction to real-world mathematics contexts. The agricultural mechanics CDE is a valid example of an authentic assessment activity.

## The Agricultural Education Model

Agricultural education at the secondary level is delivered through a model that combines contextual instruction incorporating STEM content (classroom), supervised experience activities significant to the student learners (SAE), and participation in leadership development component (FFA). These three concepts are often incorporated into a model referred to as the three-circle model of agricultural education (Figure 1).

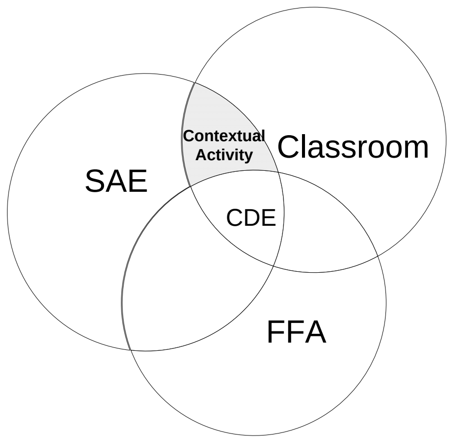


*Figure 1. A Conceptual Model of Agricultural Education*

The classroom instruction component of secondary AFNR programs provides opportunities for instruction in specific content areas. In power, structural and technical systems courses, students receive both content instruction in a traditional classroom setting and enhanced application of that content in a laboratory setting. The Supervised Agricultural Experience program (SAE) is a planned process of individualized activities focused on gaining exposure to, and experience in, a particular career area chosen by the student. Participation in organized FFA activities provides students with leadership development and competitive opportunities within the social organization. FFA membership is extended through local chapters at public schools offering regularly planned programs of instruction in agriculture, food and natural resources and approved to receive Carl D Perkins federal funds for career and technical education. Students must be paid FFA members to participate in FFA-sanctioned activities such as the State Agricultural Mechanics CDE.

In this study, the terms agricultural science and technology, agriscience, agriculture, food and natural resources, and the acronym AFNR were used interchangeably to identify public secondary school programs in agricultural education. The term agriculture, food and natural resources, or AFNR, identifies a specific career cluster in the nationwide career clusters initiative (National Association of State Directors of Career Technical Education Consortium, 2003).

The overlapping regions of the three circles demonstrate the interrelationships between classroom instruction, SAE development, and FFA participation. The shaded region defined by the overlap of classroom instruction and SAE represents a contextualized activity, focused on rigorous content and having relevance to the student's background and career goals. Career development events, which are authentic assessment activities anchored in situational contexts, are found at the point where all three circles overlap. Using graphing calculators to solve mathematics problems in the context of a real-world scenario provides an ideal situated learning activity that is suitable for authentic assessment. Additionally, this process enhances the relevance of STEM content, and allows participating students a greater opportunity to apply this learning in their daily lives.

Career Development Events

Career development events, or CDEs, are student competitive events that demonstrate meaningful connections between the classroom instruction component of the agricultural education model and real-life scenarios. These events build on rigorous content taught in the AFNR classroom, expanded through student SAEPS, and recognized through FFA participation. These CDEs assist in preparing students for agricultural careers (Brown, 2002). The National FFA Organization currently sponsors a wide range of CDEs for both individuals and teams (National FFA, 2006).

Career development events are examples of authentic assessment opportunities which allow student to demonstrate knowledge and skills in real-world settings. These events provide students opportunities to use higher-order thinking skills and work cooperatively in a wide variety of workplace situations which are essential to learning (Grady, 1994). These competitive activities provide students opportunities to apply relevant knowledge and skills to authentic situations.

Career development events in secondary AFNR programs provide a competitive opportunity for the application of principles of science, technology and mathematics (STEM) to everyday situations. Curriculum leaders in STEM areas often emphasize the importance of incorporating real-world applications in teaching secondary mathematics and science (National Council for Teachers of Mathematics, 1989; Lesh & Lamon, 1992; Texley & Wild, 1996). This incorporation, or anchoring, of career development events in contextual situations involving STEM knowledge and skills provides an opportunity to assess the relevance of those skills.

Another three-circle model (Figure 2) has been offered to assist in helping educators understand the interplay between academic rigor, contextual relevance, and the impact of social learning. The relevance of an educational context makes rigorous academics possible (Daggett, 2005). Students are often more able to demonstrate learning when placed in a real-life setting. The community aspect of this model is addressed through the social interaction provided by FFA participation.

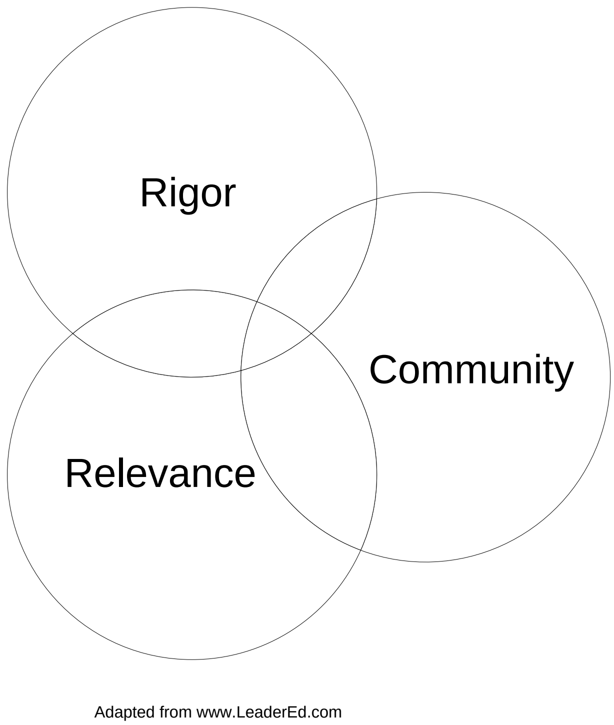


*Figure 2. A Conceptual Model of Rigor, Relevance and Community*

Student problem-solving skills can be enhanced by using an anchored teaching process. This process calls for the use of a real-world scenario, or anchor, to focus the learning environment. A review of 11 studies found anchored instruction to be effective in improving student learning (Ruzic & O'Connell, 2003). Mathematics instruction anchored in contextual settings has been shown to improve student performance across content offerings. One study (n = 50, ES = .92) identified a significant improvement in the ability of the treatment group to transfer appropriate information to similar situations (Serafino & Cicchelli, 2003). Since learning is a natural, social activity, anchoring instruction in context tends to enhance teamwork and can lead to the establishment of learning communities (Driscoll, 2000). Anchoring instruction in relevant content increases rigor, encourages active learning, enhances knowledge development, and enables the learner to transfer the developed knowledge to other situations (Bransford, Brown & Cocking, 2000). The State Agricultural Mechanics Career Development Event is an example of a contextual learning situation anchored in an authentic scenario.

## Graphing Calculators

Graphing calculators were introduced to the educational public approximately 20 years ago. These devices are designed to improve arithmetic accuracy, increase speed of calculation, and to provide a method for the learner to quickly visualize the outputs of algebraic formulas. The use of graphing calculators can facilitate active learning, and increase student participation in problem-solving (Pomerantz & Waits, 1997). Graphing calculators are widely used in educational settings, particularly standardized assessment. That students should be provided multiple content-rich opportunities to work with calculators is the stated position of recognized mathematics education organizations such as the National Council of Teachers of Mathematics (National Council of Teachers of Mathematics, 1989). The curriculum standards (TEKS) adopted in Texas in 1996 required the use of graphing calculators in high school mathematics courses. It was noted in 2001 that science assessments necessitate the use of graphing calculators as well. Commissioner Nelson (2002) directed school districts to ensure that adequate numbers of graphing calculators were available to students for testing situations. The state education agency has provided significant funds to school districts for the purchase of graphing calculators. Accordingly school districts must ensure that students in grades 9 through 11 have adequate access to graphing calculators for testing purposes, and also for daily classroom practice, and extra-curricular activities. Effective use of graphing calculators has been shown to be one component of improving mathematics performance (Texas Instruments, 2003c). In this study, graphing calculators were used in the enhancement activity demonstrated to cooperating schools, and in the written examination and team activity components of the State Agricultural Mechanics CDE.

Education in Performance Fine Arts

Fine arts education at the secondary level provides personally-relevant opportunities for students to demonstrate what they have learned. Performance fine arts opportunities at the secondary level, such as participation in band, orchestra, or choir, help students develop creativity and discipline, and provide useful opportunities to develop knowledge and skills for employment (Richmond Public Schools, 2007). Education in fine arts provides numerous opportunities for teaching decision-making, problem-solving, and collaboration. Studies indicate a direct positive correlation between student achievement and fine-arts based learning. .Students who participate in fine arts programs for four years of secondary school have been shown to outscore students who only complete one-half credit of fine arts by approximately 100 points on SAT examinations (Gardner, 2006).

STATEMENT OF THE PROBLEM

Current materials for contextual mathematics enrichment come in a wide variety of formats. In many cases, these materials are broad-based, and lack adequate contextual specificity to provide sufficient focus to accommodate students with different learning styles. Sets of mathematics problems often use content from several different disciplines, arranged in no specific order. Mathematics content may be widely scattered among different subjects in curriculum materials for secondary AFNR as well. A need exists for enrichment activities that are contextual, focused on specific situations within a thematic context. The effectiveness of these enrichment activities is increased when the activities are focused on specific opportunities for student learning. Students enrolled in power, structural and technical systems courses may benefit most from problem sets focused on specific coursework. Students participating in competitive activities, such as the agricultural mechanics CDE, may improve learning through focused enrichment activities and mathematics problems situated in authentic and relevant contexts. The agricultural mechanics CDE provides an opportunity for authentic assessment of student performance. Teachers of agriculture, food and natural resources in secondary schools anticipate that mastery of mathematics enrichment activities will improve performance in the agricultural mechanics CDE. These teachers also anticipate that success in the agricultural mechanics CDE will enhance student learning in mathematics. Will these enrichment activities improve individual and team performance on the Agricultural Mechanics Career Development Event? Will these same enrichment activities improve student learning in mathematics?

## PURPOSE OF THE STUDY

The purpose of this study was to investigate the effect of enrichment activities using graphing calculators in contextual settings on the performance of selected groups of students. Performance of students who competed in the 2008 Texas FFA Agricultural Mechanics CDE and student performance on the TAKS exit-level mathematics and science assessments were used in comparisons.

To accomplish the purposes of this study, high school students in 13 schools were provided enrichment activities in contextual mathematics using graphing calculators. This group served as the experimental treatment group. Students in 16 schools not provided enrichment activities in contextual mathematics served as the control group. The goal of the enrichment activities was to increase students' scores on the exit-level mathematics TAKS assessment and on the State Agricultural Mechanics CDE.

## RESEARCH OBJECTIVES

To accomplish the purposes of this study, the following four research objectives were developed:

Objective 1 was to describe the participants in the study and their responses to items on the questionnaire, and explore the relationships between the participants' demographic characteristics and interrelated items on the survey instrument. The findings are organized in the order the items were posed in the questionnaire (Appendix D).

Objective 2 was to compare CDE Contest outcomes; the Written Examination, Team Individual Skill scores, and Team Activity scores between teams exposed to mathematics enrichment activities and those that were not.

Objective 3 was to compare Team TAKS Mathematics and Science scores, School TAKS Mathematics and Science scores, Team Composite State Agricultural Mechanics CDE scores, perceived level of expertise with a graphing calculator, and frequency of participation in CDEs between teams exposed to contextual mathematics enrichment activities and those that were not.

Objective 4 was to explore interrelationship between Team TAKS Mathematics scores, Team Composite State Agricultural Mechanics CDE scores, and participation in fine arts courses between students exposed to contextual mathematics enrichment activities and those that were not.

## THEORETICAL BASIS FOR THE STUDY

The theoretical basis for this study is grounded by the seminal works of John Dewey and Jean Lave and Etienne Wenger. Dewey (1916) posited that instruction is most effective when integrated into a workplace setting. He felt that separate, rather than unified curriculums delivered two distinct products of marginal quality in a democratic society. Those products were a textbook-based education for some students that lacked application to work and life, and a narrowly-defined trade training for other students, limiting their social mobility. Professor Dewey viewed a dual-track system as undemocratic, educationally limiting, and not meeting the needs of society.

Lave and Wenger (1991) forwarded the concept of situated learning. Simply stated, situated learning is ‘learning by doing;’ a concept that has great significance for agricultural education. Lave and Wenger demonstrated that the social context is an important part of learning. Effective instruction is situated in a setting that has meaning to the learner. These researchers felt that the acquisition of knowledge moves along identifiable socio-cultural as well as academic benchmarks. How we learn and how we apply what we learn is as important as what we learn (Lave & Wenger).

The theoretical basis for this study can be organized by the following diagram (Figure 3) to provide clarification and scaffolding. To explain the diagram, contextualized instruction has been shown to improve student achievement in mathematics and science. Authentic assessment is an accepted measure of student achievement in a variety of areas. Graphing calculators are appropriate educational technology shown to improve student performance and achievement. Career development events are a valid form of authentic assessment. The agricultural mechanics career development event is a valid authentic assessment. Graphing calculators will improve student performance on the agricultural mechanics career development event. Agricultural mechanics career development events are valid and reliable authentic assessment instruments for mathematics.

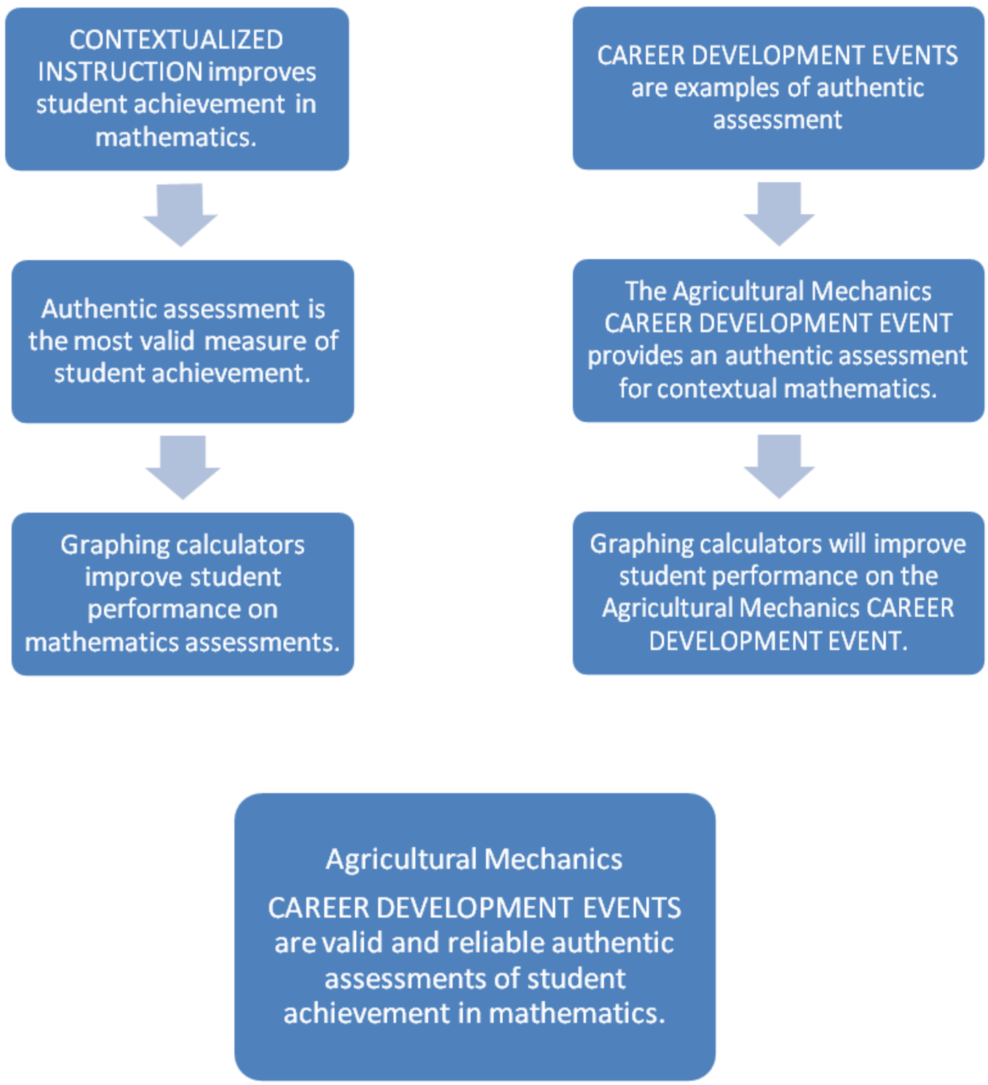


*Figure 3. A Conceptual Model of the Study*

A study by Hembree and Dessart (1986) established a positive link between use of calculators and increased student achievement and attitudes. A study by Hawkins, Stancavage, and Dossey (1998) found increased use of calculators improved student achievement on standardized tests. The use of calculators enhances students understanding of complex scientific and mathematical concepts by providing them with more time to focus on the concept and problem (Dossey, McCrone, Giordano, & Weir, 2002).

Students who are competent users of graphing calculators are more successful (Mokros, & Tinker, 1987). These authors found a substantial and positive relationship between student understanding of science topics and use of graphing calculators to solve problems. Students who solve problems that involve the use of CBL probes are able to collect actual data on motion, sound, temperature, and light. Students with greater mathematical ability and experience tend to be more successful in agricultural mechanics CDE's (Johnson, 1991). Data has shown that Texas agricultural mechanics students score as well as their peers in end-of-course assessments (Texas Education Agency, 2002). Johnson (1993) found also that the use of a calculator is strongly related to success in the agricultural mechanics career development event.

Teachers who provide opportunities for students to work with graphing calculators increase student success (Mokros, & Tinker). Opportunities exist for secondary agriculture, food and natural resources teachers to provide this type of instruction. According to the National FFA (2002), approximately 60% of the secondary agriculture, food and natural resources education programs in the United States include agricultural mechanics in their curriculum. Simulation-type problems have been shown to be effective vehicles for teaching many concepts of agricultural mechanics (Agnew & Shinn, 1991). Nelson (2002), however, noted many teachers are not familiar with use and instruction of graphing calculators. Nelson also noted that although school districts have graphing calculators on hand, they are used primarily for testing situations.

Scientific relevancy could be increased for students that seem to be uninterested in traditional approaches to science and mathematics through the use of contextual curriculums that support science and math education (Balschweid, Thompson & Cole, 2000). Experiential or problem-based learning may provide a transfer opportunity for many types of students. It has been demonstrated that problem-solving increases student retention (NCTM, 1989). Solving real-world type problems in agricultural science classes incorporates the use of the scientific method and leads to student success (Boone, 1990). Ozgün-Koca (2001) wrote that graphs are an effective means of summarizing complex information. Also, understanding and using graphs are critical skills in the career development process for all students. Gliem and Warmbrod (1986) suggested that the utilization of practical mathematical problems should be an integral component of agricultural mechanics courses.

To enhance the mathematical skills of high school agricultural science students, their teachers must become more adept at incorporating mathematics skills in their lessons. This can be done through teacher in-service opportunities that focus on the application of mathematics to agricultural problems (Miller & Gliem, 1995). In-service opportunities that incorporate specific problem-solving skills utilizing graphing calculators may improve student outcomes in mathematics. The research presented in this paper is an attempt to expand the work of Johnson (1991, 1993) and Gliem and Warmbrod (1986) within the theoretical framework of Hembree and Dessart (1986). This study will examine the effect of student access to, experience with, and use of graphing calculators for testing, class work, and extra-curricular activities on student achievement in the Texas agricultural mechanics CDE and student exit-level TAKS mathematics scores. This research falls within the Agricultural Education in Schools research priority area established by the AAAE National Research Agenda for Agricultural Education and Communication (Osborne, 2007).

## NEED FOR THE STUDY

Concerns about improving mathematics and science performance of all students, including career and technical education students enrolled in career-specific courses of study, are increasing (Petrinjak, 2008: Pivnichny, Wichowski & Heberly, 2007). Opportunities to improve student achievement by incorporating contextual applications of STEM concepts are an importance component of systemic educational improvement initiatives (Smith & O'Day, 1990). Performance ratings on statewide assessments have both intrinsic and extrinsic impacts upon school districts. Administrative hiring decisions are often based on efforts to improve district performance ratings (Stone, 2005). Teachers of certain elective courses often experience administrative pressure to justify their value to the district, and are called upon to demonstrate how their instruction can positively impact district performance on statewide assessments (Bottoms, Presson & Johnson, 1992). Agriculture, food and natural resource programs are present in approximately 90% of the PK-12 school districts in Texas. The number of programs and teachers has increased over the past ten years (Instructional Materials Service, 2007). However, continued focus on statewide assessment, and recent changes to graduation requirements have increased pressure on scheduling and affected the course offerings of many school districts (Edwards, 1999). Secondary agriculture, food and natural resource education teachers who are able to demonstrate that their contextual instruction can improve student learning of STEM concepts and contribute to school success on statewide assessments will be better able to withstand these pressures.

## LIMITATIONS

This study was limited to 200 students competing in the 2008 Texas FFA State Agricultural Mechanics Career Development Event and 30 teams participating in the 2007 Texas FFA State Agricultural Mechanics Career Development Event. The mathematics enrichment activity sessions were delivered to various sizes of student audiences, due to differing class and school enrollments. These enrichment sessions were also delivered in a variety of school settings. The generalizability of these results is limited to agriculture, food and natural resources students and teachers of agricultural mechanics courses pertinent to the 2007 and 2008 Agricultural Mechanics CDE in Texas.

## BASIC ASSUMPTIONS

One basic assumption is that students receiving the enriched mathematics instruction will compete in the 2008 Texas State Agricultural Mechanics CDE. A second assumption is that students competing in the Texas FFA Agricultural Mechanics Career Development Event in 2007 and 2008 were similar to all students who participate in this career development event. A third assumption is that FFA members are similar to other high school students.

## OPERATIONAL DEFINITIONS

For the purposes of this study the following terms are defined as follows:

Academic Excellence Indicator System (AEIS)

An ordinal rating process which allocates a local district's educational performance based on the percent of students passing the TAKS assessments, the high school completion rate, and the district's annual dropout rate. Standards for TAKS, completion rates, and dropout rates must be met for all students as well as for student subgroups such as African American, Hispanic American, European American, and Economically Disadvantaged. Factors such as Adequate Yearly Progress (AYP) are also used to determine the district's final rating. The Accountability ratings assigned to school districts based on the scoring process utilized by the AEIS system are Exemplary (E), Recognized (R), Academically Acceptable (AA), Academically Unacceptable (AU), and Not Rated. School districts may be additionally identified in this process by a series of Gold Performance Acknowledgements. Some terms that may be used to identify selected performance levels in the Acknowledgement process are Commended (C), Comparable Improvement (CI), and Texas Success Initiative (TSI) (Texas Education Agency, 2007a).

Agriculture, Food and Natural Resources Education (AFNR)

AFNR is one of the career clusters administered by the Division of Career-Technical Education of the Texas Education Agency. This cluster prepares students for professional, technical and educational careers dealing with the production, management, processing, and marketing agricultural commodities and services, such as food and fiber crops, wood products, horticultural crops, plant and animal products, and natural resources (Texas Education Agency, 2007b).

Agriscience

School-based instruction focused on laws, concepts, and principles of mathematics and science as they describe agriculture in the context of the life and physical sciences (Buriak, 1992).

All Students Tested

School districts receive TAKS scores in a variety of groupings. These groupings allow districts to more easily disaggregate and evaluate student performance data based on subgroups and other factors. All students tested means that the scores provided include those of students in special education, those receiving no special education services (regular education students), and other categories. No subgroups are removed from the score reports (Texas Education Agency, 2007a).

Authentic Assessment

Authentic assessment is the use of evaluation processes that involves students in performance measurements resembling realistic workplace situations and involving elements of contextual settings, higher-order thinking skills and teamwork activities (Wiggins, 1995).

Calculator Based Laboratory (CBL)

A portable handheld data collection device that can be connected to a graphing calculator and appropriate sensors to measure and record data about motion, temperature, light, pH, sound, and other indicators (Texas Instruments, 2003b).

Career Cluster

The Texas Education Agency uses a series of sixteen career clusters to encompass the broad range of career and technical education courses offered in public secondary schools in Texas. The clusters concept is an initiative of the U.S. Department of Education, Office of Adult and Vocational Education, and is supported by the National Association of State Directors of Career – Technical Education (Texas Education Agency, 2007b).

Career Development Events (CDE)

Twenty-five different competitive events managed by the Texas FFA Association. These events are generally conducted in the spring, and participation in state-level events is restricted to active FFA members representing schools selected for competition by an elimination process. The winners of most of these state-level events advance to compete in the analogous National FFA CDE in the fall (Texas FFA, 2003).

Career-Technical Education (CTE)

Once referred to as vocational education, career-technical education is designed to prepare secondary students for entry into the workforce and /or continue their education (Texas Education Agency, 2007b).

Commended (C)

A student who is commended for her or his exit level TAKS mathematics performance earned a score at or above the TAKS recommended performance standard for mathematics, which is a scaled score of 2400 (Texas Education Agency, 2007c).

Contextual Curriculum Integration

Examples of the contextual integration of mathematics include such real-world concepts as converting kilowatt-hours to horsepower, Ohm's Law, calculating simple and compound interest, and converting SI units to inches (Association for Supervision and Curriculum Development, 2003; Stone, 2005).

Graphing Calculator

A graphing calculator is a type of handheld calculator capable of plotting and displaying graphs, solving simultaneous equations, and performing mathematical computations with variables (Texas Instruments, 2005).

Integration

Integration is a method of teaching that draws content from different subject matter areas and focuses that content on a specific theme or context (ASCD, 2003).

Mean Score

The arithmetic average of a series of numbers is the mean (Texas Education Agency, 2007a).

Modal Score

The most frequently-occurring score in a group of scores is the mode (Texas Education Agency, 2003).

National FFA Organization

The career and technology student organization (CTSO) for students enrolled in courses in the agriculture, food and natural resources education cluster. This organization was known as the Future Farmers of America from it's inception in 1927 until 1988 (National FFA, 2002).

PEIMS

PEIMS is the acronym for Public Education Information Management System, which includes all public education data received by the Texas Education Agency regarding demographic and academic performance of students, and district personnel, financial, and organizational information. This data is collected electronically when districts submit standardized computer files defined by the PEIMS Data Standards. The major categories of data currently collected are organizational; budget and actual expenditure; faculty and staff; student demographic, program participation, school leaver; student attendance, course completion and disciplinary. PEIMS information contains only the data necessary for the legislature and the Texas Education Agency to perform their legally authorized functions in overseeing public education (Texas Education Agency, 2007a).

Science, Technology, Engineering and Mathematics (STEM)

The career cluster dealing with professional and technical services in physical, life and social science, engineering, laboratory testing, and research and development is commonly called STEM (Texas Education Agency, 2007b).

Texas Assessment of Knowledge and Skills (TAKS)

The TAKS assessment is a statewide series of mandated, high-stakes examinations in the subject matter areas of English Language Arts, Science, Mathematics, and Social Studies. At the secondary level, TAKS mathematics examinations are given in the $9^{th}$, $10^{th}$, and $11^{th}$ grades; science examinations are given at the $10^{th}$ and $11^{th}$ grade levels. Mastery of the exit-level TAKS examinations, given at the end of the $11^{th}$ grade, is prerequisite for graduation from high school. The passing standard is not set at the same level for each subject matter area. There are multiple versions of the TAKS assessment, based on level of difficulty. As of 2008, the examinations were given in three formats; the TAKS, the TAKS-A, and the TAKS-M. The TAKS examination is the format given to the majority of students. The TAKS-A (Accommodated) version is given in smaller groups, can be orally administered, has no field questions, and generally has fewer questions per page. The TAKS-A replaced the TAKS-I in 2008. In 2007 and before, student scores on the TAKS-I were not averaged into the campus summary report. The TAKS-M (Modified) format has no field questions, fewer questions per page, modified questions are generally easier, and the examination may be administered orally (Texas Education Agency, 2007a).

Texas Education Agency (TEA)

The state's central education agency, located in Austin, TX, established by the Gilmer-Aiken Act of 1949; responsible for setting TAKS standards and other accountability measures, managed by a commissioner of education appointed by the governor with the approval of an elected 15-member board of education (Texas Education Agency, 2003).

Texas Essential Knowledge and Skills (TEKS)

The TEKS are the state - adopted curriculum standards for general and career-technical education courses, adopted by the State Board of Education. These standards define the content that must be taught in each course, suggested grade level, and number of credits that can be awarded for successful completion. The statewide mandated assessment (TAKS) is an attempt to evaluate student comprehension of these essential knowledge and skills (TEKS). The TEKS for secondary mathematics education went into effect in 1996; the TEKS for agricultural science and technology education and went into effect in September 1998. The mathematics TEKS were revised slightly in 2006. The TEKS for agricultural science and technology are currently under revision by a committee process (Texas Education Agency, 2007b).

Texas Success Initiative (TSI)

A program intended to improve student success in college in relation to reducing the likelihood of academic remediation. The TSI indicator score on a district's annual

AEIS report reflects the percent of students scoring well enough on the TAKS to be exempt from demonstrating basic academic requirements at the post-secondary level (Texas Education Agency, 2007a).

## ORGANIZATION OF THE REMAINDER OF THE DISSERTATION

A review of research relating to situated cognition, authentic assessment, effects of graphing calculator usage on mathematics achievement, career development events, and the importance of secondary fine arts education is presented in Chapter II. A description of the methodology used to conduct this study is found in Chapter III. Chapter IV includes the results of the analysis of data, and presents a discussion of the findings. Chapter V contains the summary, conclusions and recommendations of the study.

# CHAPTER II

# REVIEW OF LITERATURE

## INTRODUCTION

The theoretical base for this study is closely related to the arguments used for justification of career and technical education. The integration of general and workplace education has been a cornerstone of vocational agriculture education since the passage of the Smith-Hughes Act in 1917. John Dewey supported a unified assessment process that combined content knowledge, application of that knowledge in real-life contexts, and knowledge gained from the interaction of work and life. He felt that the most successful form of education would be that which prepared the learner for life while imparting knowledge. Charles Prosser, another educational philosopher, countered Dewey's concept of unified integration, and felt that a dual-track system of general and vocational education offered the most efficient method of curing many social ills. Prosser's dual-track system emerged as the Smith-Hughes Act. To the surprise of many contemporary educators, Dewey did not support the concepts contained in that legislation (Herrick, 1996). Over the last twenty years, many educational reform efforts have focused on curing symptoms whose causes may be partially rooted in this dual-system concept.

Agricultural education can provide a model for the integration of mathematics, science and engineering concepts in a real-world context. While integrated teaching occurs in both general and vocational classrooms, it is more likely to be a methodology used in CTE classrooms (Balschweid, Thompson & Cole, 2000). Increased efforts to deliver contextual or situated learning through career and technical education should result in improved student performance and increased levels of permanent learning (Lave & Wenger, 1991). Individuals who are adept at quickly recalling personally significant knowledge are more able to apply that knowledge effectively (Carey, 2008). Participation in competitive activities offered through student organizations has recognized educational value (Reese, 2001). These competitive activities can provide a context to assess knowledge.

Integrated, contextual, or situated learning improves student performance and retention. Students who learn mathematics in a contextual setting will retain the knowledge longer, and be able to apply it to a wider variety of scenarios. This reflects Dewey's concept of pragmatism (Dewey, 1916). Pragmatism focuses on the concept of schools teaching students to become problem solvers by focusing on real-life experiences. Pragmatism also seeks to teach students to work cooperatively as preparation for adulthood.

Much of the importance of teaching and learning through participation in career development events is based on the concepts of situated cognition (Lave & Wenger, 1991) and authentic performance assessment (Wiggins, 1993). Students preparing for participation in these events experience considerable immersion in situations related to the particular competitive event. Integrating a base of conceptual mathematics into the focused scenario of a competitive event provides an ideal opportunity to measure the effectiveness of situated learning (Lave & Wenger, 1991). State education agency policies related to student access to graphing calculators during testing provides the opportunity to investigate the use of contemporary educational technology (Nelson, 2001). Relating CDE outcomes to district standardized test scores in mathematics may serve to assess the effectiveness of career and technical education in improving student performance on mandated assessment. Due to the impact of mandated assessment in contemporary educational settings, improving school performance on the Texas Assessment of Knowledge and Skills (TAKS) is a high-priority goal for many school districts (Texas Education Agency, 2007a). The career development event (CDE) concept has been a cornerstone of FFA participation for many years. These events provide opportunities for students to test skills and abilities they learn in related coursework (Shinn & Weston, 1978). The real-world contexts presented in CDEs provide a situated venue for student demonstration of classroom learning (National FFA, 2006). This authentic assessment of school-based instruction, cooperation, and teamwork reinforces the connection between secondary education and career opportunities.

## CONTEXTUALIZED INSTRUCTION

The study presented in this dissertation described the relationship between student performance on the Texas FFA Agricultural Mechanics Career Development Event (CDE) and student performance on the TAKS exit-level mathematics assessment following an enrichment activity for student use of graphing calculators. Agricultural mechanics provided the context for this study.

Students learn best in situations that are context and culture appropriate (Lave & Wenger, 1991). These situations encourage settings in which new learners, such as students who enroll in introductory courses in power, structural and technical systems, develop new skills over time. These skills are combined with existing skills in such a manner as to allow the learning of further skills more easily. Over time, these new learners move from the periphery of a group to an improved status within that group as experienced learners, or full participants. Research on curriculum integration demonstrates that students in integrated learning situations perform at a higher level than those in single-subject situations. Real life requires performance in complex situations.

Student interest is increased when the course of study is of value or interest to the learner (Brown, 2002; Glatthorn, 1994). Learning of value or interest to the learner is that which helps the learner make sense of his or her surroundings (National Research Council, 1990). This context – appropriate learning allows the learner to link new knowledge and skills with previously acquired knowledge more efficiently. The most effective learners are those who can successfully apply prior learning to new contexts. The SCANS Commission asserts their support of contextual learning as the most effective method of developing many skills needed in the real world (U.S. Department of Labor, 1991). Learning through integrated situations develops problem-solving skills more effectively than methods such as memorization and recitation (Driscoll, 2000).

Many state curriculum standards emphasize the importance of student understanding of real-world applications of mathematics (Hull, 2005).

Many of today's high school students learn better in contextual situations. This concept is widely supported by creditable entities such as the National Council for Teachers of Mathematics (National Council of Teachers of Mathematics, 1989), the American Association for the Advancement of Science (AAAS, 1990), and the National Research Council (1990, 1996). The National Council of Teachers of Mathematics, in particular, recognizes the importance of learning to apply mathematical tools to solve a widening variety of problems (Seeley, 2004). Situated learning strategies have been shown to be effective in improving student performance in mathematics (Bottoms, Presson & Johnson, 1992). Integrated or contextual learning offers significant advantages for improving the mathematics achievement of low-performing learners (Stone, Alfeld, Pearson, Lewis & Jensen, 2006). The National Council of Teachers of Mathematics understands the importance of teaching mathematics in a real-world context (1989). The recent report of the National Mathematics Advisory Panel (2008) indicates that teaching in real-world scenarios improves secondary mathematics achievement issues such as fractions, basic equations, and functions.

The educational reform efforts over the last twenty-five years have identified a great variety of impacts and effective practices for secondary education. The driving force behind this ongoing wave of reform is contained in the suggestions expounded in A Nation at Risk (National Commission on Excellence in Education, 1983). The strong positive linkage between curriculum content and student achievement has been reemphasized. The concept of students' occupational preferences having an impact curriculum revision decisions is forwarded, and the integration of science, mathematics, and agricultural education is identified (National Commission on Excellence in Education, 1983). Academic rigor is of equal importance to career and technical education. This report also addressed the significance of the concept of age-appropriate curriculum content (Havighurst, 1971), effective professional development for teachers, and the significance of educational technology. Project 2061 reminds Americans that narrow vocationalism will not provide an adequate educational foundation for the workforce of tomorrow. All students need to be effectively anchored with skills and knowledge in science, communication, life-long learning, and reasoning (American Association for the Advancement of Science, 1990).

The National Research Council and the American Association for the Advancement of Science repeatedly emphasize the importance of contextual learning situations, linking content across subject matter disciplines, and encourage opportunities related to mathematics and science and the world of work (American Association for the Advancement of Science, 1990; National Research Council, 1988, 1990, 1996). Problem-solving skills developed through contextual learning situations increase student achievement. Contextual learning also tends to improve retention and recall skills (Edwards, Leising & Parr, 2002). A semester-long mathematics-enhanced AFNR course used an embedding process similar to that identified by Stone, Alfeld, Pearson, Lewis and Jensen. The researcher used a posttest only control group design to determine that the enhancement significantly reduced the need for mathematics remediation at the postsecondary level (Parr, 2004). The Texas Success Initiative (TSI) is one example of a measure of reduction of postsecondary remediation. However, in a similar study of contextual classroom treatment (n = 38, ES = .13), the mean score of the experimental group was 1 full point higher than the control, but results were not statistically significant at the a priori level of .05 (Parr, Edwards & Leising, 2009).

Some of today's students seem to lack what can be called mental mathematics agility. Subject-matter specialists have observed that many students are taught the rules of mathematics, but are not taught applications of mathematics. The content of the TAKS exit –level mathematics assessment is composed of approximately equal amounts of Algebra I and Geometry objectives. Many of the most-often missed TAKS objectives are those objectives dependent upon students' conceptualization skills (Silvey, 2007).

In best-practice scenarios, effective learners combine information from the activity itself, the context of that activity and their previous experiences to make sense of the problem at hand. Learning in context enables students to gather information from different sources to address issues of personal significance and transfer the knowledge developed in the process to future situations (Edwards, 2000). Effective teaching uses authentic or real-world settings to assess student performance. These concepts combine to define the concept of situated learning (Lave & Wenger, 1991). Cooperative learning, building on previously-acquired knowledge and skills, and utilizing the students' personal experiences are importance components of situated or contextual learning (Smith & O'Day, 1990; Hull, 2005). Embedding the knowledge in an authentic context is critical to the situated learning process (Lave & Wenger, 1991). College readiness standards call for learners to be able to use mathematics to develop solutions to real world problems (EPIC, 2008). Instructional context has been shown to have significant influence on student achievement in mathematics. Secondary agricultural education serves as that effective instructional context on a daily basis for many students (Shinn, Briers, Christiansen et. al., 2003). For situated cognition and anchoring efforts to be effective for learners, mathematics and science activities must be smoothly imbedded and indistinguishable from specific agricultural mechanics content (Balschweid, Thompson & Cole, 2000).

Research indicates the need for integrated educational activities anchored in real-world frameworks (Bransford, Brown & Cocking, 2000). This anchoring process combines the student's understanding of mathematical processes with examples of real-world applications. Serafino and Cicchelli (2003) demonstrated that mathematics instruction anchored in contextual settings improved student performance across content offerings. In an investigation of anchored instruction involving two similar groups of elementary students ($n$ = 50), participants with high prior knowledge scored higher on problem-solving situations than participants with low prior knowledge.

Johnson (1991) has previously demonstrated the efficacy of linking agricultural mechanics instruction to real-world mathematics contexts. Employers prefer to hire students who have the ability to apply their skills and knowledge in workplace contexts (Stone, Alfeld, Pearson, Lewis & Jensen, 2006). However, a recent report fails to identify evidence whether integrated thematic instruction is more effective than in-isolation approaches to teaching secondary mathematics. Lack of real-world relevance was not identified as one of several causes of mathematics anxiety (National Mathematics Advisory Council, 2008).

## AUTHENTIC ASSESSMENT

The concept of authentic assessment offers an effective, unified method for evaluating the skills desired in contemporary learners; content knowledge, the ability to apply that knowledge in real-life contexts, and useful knowledge gained from cultural interactions. Authentic assessment can be defined as “engaging and worthy problems or questions of importance, in which students must use knowledge to fashion performances effectively and creatively. The tasks are either replicas or analogous to the kinds of problems faced by adult citizens and consumers or professionals in the field” (Wiggins, 1993, p. 229).

The National Council of Teachers of Mathematics has proposed fourteen educational content standards for secondary instruction. These standards provide a focus for assessment by identifying the mathematical knowledge and skills a student should be able to perform by the end of grade 12. The content standards include number and operations, algebra, geometry, measurement, and data analysis and probability. The process standards are problem solving, reasoning and proof, communications, connections, and representation (National Council of Teachers of Mathematics, 1989). Student assessment standards that address the NCTM content standards include problem solving, reasoning, and mathematical procedures (Suydam, 1990). These nationally-recognized standards are reflected in the ten objectives of the exit-level TAKS mathematics assessment. Those exit-level objectives are functional relationships, properties and attributes of functions, linear functions, linear equations and inequalities, quadratic and other nonlinear functions, geometric relationships and spatial reasoning, two- and three-dimensional representations, measurement and similarity, percents / proportions / probability / statistics, and mathematical processes and tools (Texas Education Agency, 2003).

Analysis of statewide Mathematics exit TAKS results for 2007 indicated that 80% of the students tested met the passing standard and 19% were commended for their performance (Texas Education Agency, 2007). The 2008 exit level TAKS assessment for mathematics was held on April 30. Results for 2008 indicated that 79% of the students met the passing standard and 24% were commended (Texas Education Agency, 2008).

National trends in mathematics assessment in the twenty years following introduction of the electronic calculator indicated that students exhibited effective computation skills, but showed lower scores on problem-solving. Modal scores for secondary students trended lower than elementary scores in most areas, particularly decimals, perimeters, areas and problem solving. In particular, problem solving scores in career contexts were generally in the 80 range. Other areas needing improvement at the secondary level were fractions, volumes, and reading and interpreting graphs (Suydam, 1984; Charles & Lobato, 1998).

The concept of authentic assessment has gained greater significance over the last ten years. Authentic assessment in mathematics can involve graphing calculators in problem-solving contexts. Traditional methods of teaching mathematics apart from real-world context have not adequately improved student understanding. For any type of assessment to be considered authentic, the process must contain the critical components of the development of in-depth understanding, contextual learning, and having some value beyond the assessment itself (Romberg, 1994). Abilities in solving practical, real-world problems and developing understandings of how the world works are two of the four recognized curriculum blocks necessary to develop scientifically literate students through situated learning (Pate, McGinnis & Homestead, 1994; Ahlgren & Kesidou, 1995). For assessment to be authentic and effective, solving a real-world scenario as an end product must be identified as a curriculum goal at the beginning of the learning process (Wiggins, 1995). Assessing the effectiveness of situated learning necessitates the use of tools stronger than written tests. The assessment process must also involve measuring other aspects that are important to the learner (Driscoll, 2000). Students retain knowledge for longer periods and apply that knowledge in related settings when learning takes place in real-world settings (Daggett, 2005).

Secondary instruction in agriculture, food and natural resources provides a broad base of instruction in many disciplines. Critical concepts in biology, physics, and chemistry are addressed in learning agricultural content, and mathematics is crucial to interpreting and applying solutions to the context (Shepardson, 1929). The National Research Council and other entities tend to define mathematics as a science of patterns, the language of science, a formal language for understanding natural phenomena (National Research Council, 1990; Association for Supervision and Curriculum Development, 2003). These patterns are useful in defining the context of the phenomena found in the world around us.

## THE AGRICULTURAL EDUCATION MODEL

Agricultural education at the secondary level is delivered through a model that combines contextual instruction incorporating STEM content (classroom), supervised experience activities significant to the student learners (SAE), and participation in leadership development component (FFA). These three concepts are often incorporated into a model referred to as the three-circle model of agricultural education.

The classroom instruction component of secondary AFNR programs provides opportunities for instruction in specific content areas. In power, structural and technical systems courses, students receive both content instruction in a traditional classroom setting and enhanced application of that content in a laboratory setting. Instruction in power, structural and technical systems may provide the best opportunity for broad, contextual learning in science (Laird & Kahler, 1995). The Supervised Agricultural Experience program (SAE) is a planned process of individualized activities focused on gaining exposure to, and experience in, a particular career area chosen by the student. These types of informal learning activities provide excellent opportunities for learning mathematics and science concepts in real-life settings (Edwards, Leising & Parr, 2002).

Participation in organized FFA activities provides students with leadership development and competitive opportunities within the social organization. Informal mathematics and science learning also occurs in community-based settings. FFA membership is extended through local chapters at public schools offering regularly planned programs of instruction in agriculture, food and natural resources and approved to receive Carl D Perkins federal funds for career and technical education. Students must be paid FFA members to participate in FFA-sanctioned activities such as the State Agricultural Mechanics CDE.

The overlapping regions of the three circles demonstrate the interrelationships between classroom instruction, SAE development, and FFA participation. The shaded region defined by the overlap of classroom instruction and SAE represents a contextualized activity, focused on rigorous content and having relevance to the student's background and career goals. Career development events, which are authentic assessment activities anchored in situational contexts, are found at the point where all three circles overlap.

One of the outcomes of this three-circle model is the enhanced relevance of rigorous STEM content. Academic rigor is of equal importance to career and technical education (National Commission on Excellence in Education, 1983). This educational product is a critical component for preparing secondary students to address life and workplace situations that were unforeseen when those students developed their six-year graduation plans in middle school. Rigor is reinforced by authentic relationships between curriculum standards, effective classroom instruction, and appropriate assessment (Daggett, 2005).

Proponents of career and technical education maintain that their content areas offer the ideal opportunity for students to apply academic learning to real-world scenarios (Brown, 2002). For the opportunity to deliver its potential, AFNR teachers must reinforce the knowledge and skills taught in core content areas and assist students in applying those skills to authentic, real-world settings. An adaptation of the three-circle conceptual model based on the educational needs of today's students and schools is useful in understanding the relationship between rigor, relevance, and community. Agriscience teachers must be aware of the rigorous content of core subject areas, and continually take steps to embed that content into relevant assessment scenarios. This process more realistically prepares students for employment and life in the community (Daggett, 2002). Student participation in FFA career development events can provide an authentic means of assessing content knowledge and skills in a scenario that replicates real-world situations and requires teamwork and collegiality. Participation in leadership development and group dynamics provides students with a phased entry into the adult community.

In some schools, educational leaders may not view secondary agriculture, food and natural resources instruction as effectively enhancing the academic skills of all groups of students (Dyer, Breja & Ball, 2003). However, a common criticism of contemporary educational settings is that content-specific academic knowledge and skills are taught in unconnected settings. Application of these unconnected knowledge and skills is seldom addressed in the contemporary school. When rigor and relevance are added to the educational setting, student achievement is enhanced. The integration of career and technical and general education into real-world scenarios allows participating students a greater opportunity to apply this learning in their daily lives (Daggett, 2005).

## CAREER DEVELOPMENT EVENTS

Career development events (CDE's) are an important part of agricultural education. These educational events are organized by the National FFA Organization and state FFA associations, and sponsored by postsecondary education, business and industry, and individuals (Texas FFA, 2003). Participation in career development events is focused on helping secondary students develop individual responsibilities, foster skills in teamwork and collaboration, and promote communication. A preferred societal benefit of participation in CDEs is that students will learn to recognize the value of ethical competition, goal-oriented motivation, and personal achievement in daily life (National FFA, 2006). The workplace skills developed in preparation for career development events are also identified in the SCANS report (U.S. Department of Labor, 1991). FFA members also identify these types of skills as appropriate outcomes of competitive participation (Zirkle & Connors, 2003).

State rules generally follow national rules, with adaptations for conditions in each state. State CDE activities are based on competencies suggested by the National

FFA Organization (National FFA, 2002). These underlying competencies are identified by a committee composed of representatives of business and industry. The competency list is reviewed and revised on a 5-year cycle. Each state association is represented in at least one National FFA CDE.

Career development events are an opportunity to perform real-world assessment of student skills (National FFA, 2006). The importance of the extracurricular aspects of mathematics education is highly placed in systemic reform initiatives. It is critical to recognize that some students may learn better in cooperative problem-solving contexts (NSF, 1998). Students must develop abilities to solve complex problems to be successful in the workplace (Texas Education Agency, 1998a). Career development events in agricultural mechanics are designed to identify students who have developed the competencies and skills needed for success in the constantly changing workplace. Career development events are designed to incorporate the most current teaching technology. Students must apply a wide range of technologies to be successful in the workplace (Instructional Materials Service, 2002). Career-technical education has a history of using authentic assessment activities for student evaluation. These activities have often utilized work samples, demonstrations, and product development as measures of performance against specified learning objectives (Elliott, 1991). Ozgün-Koca (2001) stated that instructional programs should enable students to use representations to interpret physical and mathematical situations. The use of technology-based tools in career development events improves student success by enhancing the instructional process (National Research Council, 1988). Students need opportunities to apply their mathematics knowledge and skills in an array of workplace settings. This allows the learners to understand the importance of timing and application in real-world settings (Stone, Alfeld, Pearson, Lewis & Jensen, 2006).

Today's FFA career development events were originally called judging contests. The first agricultural mechanics judging contest was held in 1972 (Horner, 1996). This event required students to complete a written examination, a problem solving component, and a series of individual mechanics skills. Based on recommendations from the American Society of Agricultural Engineers (now ASABE), the original event encompassed the five ASAE instructional areas of power and machinery, structures and environment, soil and water management, electrical power and processing, and general agricultural mechanics skills. Three of these five areas were to be included in each year's contest, and alternated on a five-year rotation. To compete at the national level, a state team must be composed of three members. The first state agricultural mechanics CDE in Texas was held in College Station in April, 1974.

The term judging contest was replaced with career development event, introducing the acronym CDE, based on research conducted by Shinn & Vaughn (1994). As a result of adopting the recommendations outlined in this report, the individual skill activities and written examination were retained, and a team activity was added to the National Agricultural Mechanics CDE in 1996. One preferred outcome of secondary mathematics instruction is that students will become proficient at cooperative problem-solving (National Research Council, 1990). The team activity component of the agricultural mechanics CDE is a cooperative problem-solving activity.

The structure of the Texas FFA Agricultural Mechanics CDE is patterned after the national event. Each chapter may enter a team of three or four members in their Area event (Blaha, 2005). The three teams with the highest placing in each FFA Area qualify to compete in the annual Texas FFA Agricultural Mechanics CDE. This event is held in April each year at Sam Houston State University. The winner of this event advances to compete in the National Agricultural Mechanics CDE in the fall. The Agricultural Mechanics Career Development Event is a themed event. Each event is composed of three distinct sections; a written exam, three individual student skill activities, and a team activity (Instructional Materials Service, 2002). At the Professional Development Conference each summer, members of the Texas Agricultural Mechanics Committee identify the theme and machinery focus for the upcoming event, and specify the three skill areas to be included. The skill areas are selected from machinery and equipment, industry and marketing, energy, structural, and environmental and natural resource systems.

The first section of the agricultural mechanics CDE is the written examination. The written examination consists of 100 objective, multiple-choice questions. Ten to twenty of these questions involve mathematical computations. The team event utilizes a cooperative effort to solve problems based on a specific scenario related to the annual theme. The theme for the 2007 event was materials handling. Questions on the 2007 examination were related to agricultural mechanics as it is applied to materials handling. The theme for the 2008 event was poultry processing. Questions on the 2008 examination were related to agricultural mechanics as it is applied in the poultry industry. These questions involved mathematics concepts such as percentages, measurements, sequences, computations, and understandings of the significance of numbers. Students were provided graphing calculators for use with both the written examination and the team activity.

The second section of the contest was composed of three individual skills-based activities. Still focusing on the poultry industry, the designated skills areas for 2008 were machinery and equipment, structures, and power. The equipment used as an example for that skill area was the tractor-operated front-end loader. The energy skill centered on hydraulic pumps, motors, circuits, and controls. The structure skill focused on concrete applications.

The third section of the contest was a team activity. The team event utilizes a cooperative effort to solve complex, multi-system agricultural problems based on a specific scenario related to the annual theme. This section brought all aspects of the other components into a themed application problem. Event managers also provided students with graphing calculators for the team activity. The winner of the event was determined using the total scores of the top three members of each team. The event theme and the individual skill areas are determined annually approximately three years in advance by teachers participating on the Texas FFA Agricultural Mechanics Committee. The theme for the 2007 event was materials handling. The 2007 team activity related to agricultural mechanics as it is applied to materials handling. The team activity the 2008 event focused on poultry processing. The mathematics involved in these events is directly related to the theme (Stone, Alfeld, Pearson, Lewis & Jensen, 2006).

Career development events in agricultural mechanics are intended to assess the competencies and skills students need for success in a constantly changing workplace. Students must develop abilities to solve complex problems in authentic contexts to be successful in the workplace (Texas Education Agency, 1998). Career development events incorporate the most current teaching technology. Students must be able to apply a wide range of technologies to be successful in the workplace (Instructional Materials Service, 2002). Effective, rigorous instruction should enable students to use representations or scenarios to interpret physical and mathematical situations (Ozgün-Koca, 2001). Using technology-based tools in educational settings improves student success through enhanced instruction (National Research Council, 1988). Individual and team scores on the State Agricultural Mechanics CDE are used as outcome measures in this study.

Project 2061 stresses the need to promote group learning as a best practice for enhancing student learning and improving achievement, and also points out the importance of teaming activities in learning (American Association for the Advancement of Science, 1990). Slavin (1995) found that cooperative problem-solving increases student effectiveness. Marzano, Pickering and Pollock identify cooperative learning as an effective teaching strategy leading to academic rigor (Hull, 2005). Some individuals, however, have questioned the effectiveness of CDEs and other student organization activities to effectively contribute to either development of career interest or workplace skills (Zirkle & Connors, 2003).

The Texas Agricultural Mechanics CDE provides graphing calculators for students to use during the team problem-solving activity and on the written examination. This practice was initiated in 2000. Problem solving with graphing calculators, and interaction between team members, is an effective method of instruction when the problem is carefully chosen (Grouws & Cebulla, 2000). Students experience greater success when using graphing calculators for team problem - solving because concepts and skills can be employed jointly (Texas Instruments, 2003c). Dossey, McCrone, Giordano and Weir (2002) found that peer learning enables students to test and revise ideas within the group, develop solutions jointly, and arrive at more meaningful conclusions, reinforcing the value and effectiveness of cooperative learning. The agricultural mechanics CDE is an example of an authentic assessment activity that provides a learner-significant context event which balances team problem-solving and individual skill performance with a written knowledge exam. ++++

## GRAPHING CALCULATORS

The hand-held electronic four-function calculator was introduced to American consumers in 1966. The speed and accuracy delivered by this use of technology has impacted the mathematics abilities and capabilities of the public in many ways (McCauliff, 2004). Since that time, the public has displayed a variety of opinions about the significance of electronic calculators and mathematics education (Bell, 1977). Bell correctly predicted that within ten years, the impact of this technology would have major implications on mathematics instruction and student learning. Students will develop and improve skills by using the tools learned in schools, whether those tools are electronic or pencil-and-paper. Calculators have allowed students of all skill levels to master computation, increase arithmetic accuracy, and move on to developing analytical and problem-solving skills (Pomerantz & Waits, 1997). A study of elementary school students (n = 37, ES = 1.19) demonstrated that the use of calculators in a directed study session allowed students to spend more time focusing on solving problems rather than rechecking calculations for accuracy (Rittle-Johnson & Kmicikewycz, 2008).

The use of the calculator has replaced the pencil-and-paper process of computation in schools, and at all levels of society (National Research Council, 1990). Over time, electronic graphing calculators have permeated the structure of school mathematics instruction at several grade levels. This is reflected in the mandated use of graphing calculators on the exit-level TAKS assessments (Nelson, 2002). Bell (1977) also recommended the development of instructional materials incorporating graphing calculators and greater in-service opportunities for teachers. If school districts are to effectively address the NCTM content standards, students must have access to appropriate technology. Addressing these standards effectively implies that students have full-time access to graphing calculators, and that students learn to use technology to solve problems (Suydam, 1990).

Within ten years of the introduction of the calculator, studies indicated improvement in test scores when calculators were used in controlled situations by students with low mathematical ability. In a study comparing two treatment groups (n = 34, ES = 0.12), Gaslin (1975) found that calculators had a positive impact on secondary mathematics achievement of low-ability or low-achieving students on problem sets dealing with area and volume, linear equations, statistics and probability, and ratios. These subject matter areas are included in the exit-level TAKS mathematics objectives today (Texas Education Agency, 1998b). All Texas students must demonstrate mastery of these objectives to graduate from high school. Currently, Texas does not offer a general mathematics course at the high school level, Algebra I is a the gatekeeper high school mathematics course, and some discussions support moving more algebraic instruction into the middle school mathematics curriculum (Piccolo, 2006).

In a review of previous calculator research, Roberts (1980) found that the majority of secondary-focused studies (*n* = 13) indicated improvement in computational ability based on calculator usage, and that more than half of the studies showed improvement in attitudes about mathematics. Educational leaders in mathematics have identified the importance of graphing calculator use in improving and enhancing skill development for all groups of students. These leaders also emphasize the importance of contextual learning and problem solving (Charles & Lobato, 1998).

In a meta-analysis of studies up to that time (*n* = 79), Hembree and Dessart (1986) found that many mathematics teachers were reticent to use graphing calculators, even though their use allowed students to perform calculations more efficiently and accurately, regardless of skill level. The researchers felt that calculators would allow students to make greater connections between school-based learning and real-world observations. A chi-square statistic ($H$) was used to compare effect sizes. In the secondary grade studies reviewed ($n = 41$, $H = 0.14$), students using calculators placed consistently higher than those using-pencil-and-paper calculations. Results also indicated improved attitudes about mathematics and greater efficacy in mathematics among students using calculators.

Johnson (1993) extended the conclusions of Hembree and Dessart to student achievement in agricultural mechanics CDEs. The 1993 Johnson study found that most participants had access to a calculator for routine class-work, extra-curricular activities, and standardized testing. Students participating in this study ($n = 73$) indicated that the use of a graphing calculator improved their achievement in mathematics, agricultural science, and science. Findings of this study indicated that more than 1/3 of the variation in individual and team scores could be attributed to number of mathematics courses completed ($r = 10$) and calculator usage ($r = .22$). These findings were re-affirmed a decade later, with similar observations regarding efficacy and achievement (McCauliff, 2004).

Heller, Curtis, Jaffe and Verboncouer focused on graphing calculator use in Algebra I and effects upon student achievement in a multi - state study. Their efforts incorporated the use of a demographic survey and standardized end-of-course examination in two states, and used student scores on standardized assessments as covariates. They found ($n = 458$, ES = .76) that students who used graphing calculators in class scored higher on the end-of-course mathematics administered (Heller, Curtis, Jaffe & Verboncouer, 2005). Students with more frequent access to graphing calculators during classroom instruction performed significantly better than those lacking frequent access (ES = .39).

Results of a Delphi study by Shinn (2007) indicated that agricultural mechanics instruction should place more emphasis on problem-solving scenarios. The study also surfaced the need for a greater number of in-service offerings that include situated mathematics instruction and training with contemporary educational technology. Situated learning provides those content-rich opportunities for graphing calculator use.

Graphing calculators are first introduced as a component of standardized assessment in Texas at the $8^{th}$ grade level (Texas Education Agency, 1998b). Before this time, mathematics teachers have generally provided their students with opportunities for guided practice with graphing calculators. In many cases, science teachers have not provided these same opportunities. This may be due to a shortage of graphing calculators in science laboratories. The use of graphing calculators is more often viewed as a math skill rather than a science skill. Gathering data is often perceived as a science skill, not a math skill. Interpreting the data contained in graphs is equally perceived as both a math skill and a science skill, further complicating the issue. Combining mathematics skills and data-gathering skills in contextual settings should increase relevance for student learners and improve achievement (Shinn, Briers, Christiansen, et al., 2003).

Opportunities should be provided for teachers and students to work with graphing calculators across a curriculum (Ozgün-Koca, 2001; Lindner, Edney & Jones, 2003). Corporate entities are currently making attempts to expand the knowledge base of teachers about the instructional use of graphing calculators. Texas Instruments, the leading producer of graphing calculators for education, has developed an agriculture-based mathematics curriculum called TI AgriScience™ and provides teacher training sessions around the country. The curriculum objectives of TI AgriScience™ are to integrate agricultural content deeply into science and mathematics courses, identify mathematics and science concepts commonly situated in agricultural contexts, enhance student learning experiences with real world activities, encourage the use of technology and hands-on learning, and promote teacher collaboration across the curriculum (Texas Instruments, 2003a).

Opportunities to integrate graphing calculator techniques into real-world applications are provided throughout the curriculum. One way to improve student mathematics skills is through the use of graphing calculators (Charles & Lobato, 1998; Ozgün-Koca, 2001). Using graphing calculators in secondary agriculture, food and natural resources classrooms should not result in budget increases, but will allow districts to make better use of existing equipment. Research conducted by the CTGV demonstrates the need for integrated educational activities anchored in real-world frameworks (Bransford et al.; Driscoll, 2000). Oakes (1997) suggested that using a method combining discovery science with real-life situations will increase student understanding of both calculator use and science concepts. Balschweid et al. (2000), however, noted that little evidence exists to show that general education teachers anchor their teaching with real-life examples in agricultural contexts. As early as 1983, the

National Science Board recognized the need to incorporate more hands-on science experiences for students (National Research Council, 1988).

Current educational technology includes graphing calculators. The current state-wide curriculum standards, called the Texas Essential Knowledge and Skills, or TEKS, were implemented in 1996. The curriculum required the use of graphing calculators in high school courses. Commissioner Nelson of the Texas Education Agency (2001) directed school districts to ensure that adequate numbers of graphing calculators were made available to students for high-stakes testing situations. The state education agency has provided significant funds to districts for the purchase of graphing calculators. Students should have multiple opportunities to work with calculators. Nelson (2001) noted that science assessments also necessitate the use of graphing calculators. Accordingly, school districts must ensure that students in grades 9 through 11 have adequate access to graphing calculators for daily classroom practice, homework, and extra curricular activities.

The 2007 Texas Agricultural Mechanics CDE involved teams of students using graphing calculators to solve problems, continuing a practice introduced in 2000. Slavin (1995) found that cooperative problem-solving increased student effectiveness. Students experience greater success when solving problems because concepts and skills can be employed jointly. Complex calculations are an integral component of the problems in the world around us, and are present in the Agricultural Mechanics CDE. The Agricultural Mechanics CDE integrates cognitive problem-solving and psychomotor skill performance in an authentic context.

The theoretical framework for this portion of the study is grounded by the meta-analysis conducted by Hembree and Dessart (1986). Their findings established a positive link between use of calculators and increased student achievement and attitudes. Hembree and Dessart reiterate Suydam's suggestions that 1) effective procedures for calculator use include learning basic facts, 2) calculator use with specific mathematical subject matter in grades K – 12, and 3) effects of curriculum emphasis changes would benefit from further study.

A study by Hawkins, Stancavage, and Dossey (1998) found increased use of calculators improved student achievement on standardized tests. According to Dossey et al. (2002), the use of calculators enhances students understanding of complex scientific and mathematical concepts by providing them with more time to focus on the concept and problem. This study also reinforces the value and effectiveness of cooperative learning.

Students who are competent users of graphing calculators are more successful. Mokros and Tinker (1987) found a substantial and positive relationship between student understanding of science topics and use of graphing calculators to solve problems. Research indicates the need for integrated educational activities anchored in real-world frameworks (Bransford, Brown & Cocking, 2000). Students who solve problems that involve the use of CBL (calculator-based laboratory) probes are able to collect data on motion, sound, temperature, and light from their own environment. Students with greater mathematical ability and experience tend to be more successful in agricultural mechanics CDE's (Johnson, 1991). Data has shown that Texas agricultural mechanics students score as well as their peers in end-of-course assessments (Texas Education Agency, 2007c). Johnson (1993) also found that the use of a calculator is strongly related to success in the agricultural mechanics career development event.

Teachers who provide opportunities for students to work with graphing calculators increase student success. Opportunities exist for agricultural science teachers to provide this type of instruction. According to the National FFA (2002), approximately 60% of the agricultural science programs in the United States include agricultural mechanics in their curriculum. Simulation-type problems have been shown to be effective vehicles for teaching many concepts of agricultural mechanics (Agnew, & Shinn, 1991). Nelson (2002), however, noted many teachers are not familiar with the instructional use of graphing calculators. Nelson also noted that although school districts have graphing calculators on hand, they are used primarily for testing situations.

Graphing calculators are first introduced as a component of standardized assessment in Texas at the 8$^{th}$ grade level. Prior to this time, mathematics teachers have generally provided their students with opportunities for guided practice. In many cases, science teachers have not provided these same opportunities. This may be due to the teachers' lack of familiarity with graphing calculators. However, secondary science teachers may not have access to full classroom sets of calculators. The use of graphing calculators is more often viewed as a mathematics skill rather than a science skill. Secondary mathematics teachers usually have access to classroom sets of graphing calculators. Gathering data is often perceived as being a science skill, not a math skill.

Interpreting the data contained in graphs is more often perceived as a math skill (Heller, Curtis, Jaffe & Verboncouer, 2005).

## EDUCATION IN PERFORMANCE FINE ARTS

Fine arts education has been identified as a curriculum area that has the potential for contributing to student achievement (Cohn, 2006). School districts have the flexibility to expend funds allocated under the No Child Left Behind Act of 2001 to support arts education. Integrated fine arts programs have had some effectiveness in improving mathematics achievement at the elementary level.

Research in fine arts education (62 studies) seems to indicate that music instruction improves mathematics achievement in the areas of spatial and temporal reasoning skills. These skills are essential for the acquisition of mathematics skills (Spelke, 2008). Multiple years of arts education tend to result in correlations to higher SAT scores in mathematics (Ruppert, 2006). Education in fine arts also teaches students to work cooperatively, a SCANS skill.

Studies of the impact of fine arts education in Texas support other findings that indicate higher SAT scores for students involved in fine arts programs at the secondary level. Researchers found a significant difference in dropout rates and AEIS ratings among campuses based on enrollments in fine arts programs (Texas Coalition for Quality Arts Education, 2007).

Results of a recent Delphi study affirm that contextual mathematics abilities are necessary skills for AFNR teachers (Barton, 2002). To enhance the mathematical skills of high school agricultural science students, their instructors must become better teachers of mathematics skills. This can be done through the development of teacher opportunities that focus on the application of mathematics to solve agricultural problems (Miller & Gliem, 1995). A need exists for in-service opportunities that incorporate specific problem-solving skills utilizing graphing calculators. This study expands the work of Johnson (1991, 1993) and Gliem and Warmbrod (1986) within the framework of Hembree and Dessart (1986) by looking at the impact of student access to, experience with, and use of graphing calculators for testing, class work, and extra curricular activities on achievement in the Texas FFA Agricultural Mechanics CDE.

This research addresses Research Priority Area 2 of Agricultural Education in Schools, established by the American Association for Agricultural Education (Osborne, 2005). The identification and development of materials focusing on the intersection of agriculture, food and natural resources education and general education is a priority initiative.

# CHAPTER III

# METHODOLOGY

The study employed a causal-comparative quasi-experimental design (Gall, Gall & Borg, 2003). Subjects were selectively exposed to a treatment, but were neither randomly selected nor assigned to the treatment group. Three distinct data sources were used to provide information for this study; a demographic and informational survey of participants, results from subjects' participation in the State Agricultural Mechanics CDE, and TAKS Exit-level Mathematics and Science scores for each school and team.

Data from the first component consisted of individual student responses to a survey instrument administered during the State FFA Agricultural Mechanics Career Development Event. The second component of this study included of three separate components and sources of data; Written Exam Scores, Individual Skill Scores, and Team Activity Scores from the 2008 State Agricultural Mechanics CDE. Existing data from the 2007 CDE were also used in comparisons with the results of the 2008 CDE.

The third component of the study consisted of the TAKS Exit-level Mathematics and Science scores for the schools and the students competing in the CDE. Individual student scores, provided by each school district were averaged together to create a Team TAKS mathematics and a science score. Publicly available 2007 and 2008 statewide averages for the TAKS Exit-level Mathematics and Science scores were used for comparison.

This chapter is laid out in the following manner. A description of the experimental design, and the composite variables created and used in the analysis, is followed by a description of the population, the sample, and the process used to select the sample. A description of the experimental treatment is then provided. The data collection methods used to gather information for each of the three components of this study, the survey instrument, the CDE scores, and the TAKS scores, completes the chapter.

## EXPERIMENTAL DESIGN

Three data sources were used to complete this causal-comparative quasi-experimental design. Data from the second source, the Agricultural Mechanics CDE, were used to create an outcome variable. The school or total team score in the State Agricultural Mechanics CDE was calculated to develop the variable Team Total Score. Comparisons were made between schools receiving the treatment and schools choosing not to receive the enhancement. Schools not receiving the mathematics enrichment activity were used as a control group.

A second outcome variable of this study was individual student scores on the written examination portion of the 2008 State Agricultural Mechanics CDE. Comparisons were made between written examination scores of cooperators and non-cooperators. Students not receiving the mathematics enrichment activity served as the control for this variable.

The third outcome variable was the 2008 TAKS exit-level mathematics and science scores of the schools participating in the CDE process. Comparisons were made between schools receiving the mathematics enrichment activity and schools not choosing to receive the enrichment activity. Schools not receiving mathematics enrichment activity and participating in the 2008 State Agricultural Mechanics CDE served as the control for this variable.

To test the differences between cooperators and non-cooperators, seven outcome variables were developed from team performance data and used to conduct the inferential statistical tests of this study. These composite variables were Average of Written Examination Scores, Team Activity Score, Team Total CDE Score, School TAKS Mathematics Score, School TAKS Science Score, Team TAKS Mathematics Score, and Team TAKS Science Score. These outcome variables were then entered into the SPSS Survey data file and allocated to the respective members of each team.

The Average of Exam Scores (AVGexamscore) was derived by summing the 3 highest exam scores for each team, dividing by 3, and allocating this score to each respective team member. The Team Activity Score (ActivScore) was derived by dividing the activity score of each team by the number of team members (3) and allocating that number to each team member respectively. The Team Total CDE Score (TotCDEscore) was derived by dividing each team's total score by 3 and allocating that number to each team member respectively.

The School TAKS Mathematics Score (SchMATHscore) was derived by dividing each school's 2008 Exit Level Mathematics TAKS score by 3 and allocating that number to each team member respectively. The School TAKS Science Score (SchSCIENCEscore) was derived by dividing each school's 2008 Exit Level Science TAKS score by 3 and allocating that number to each team member respectively.

The Team TAKS Mathematics Score for each team member was derived by dividing the totals of those team member's 2008 Exit Level Mathematics TAKS scores by 3 and allocating that number to each team member respectively. The Team TAKS Science Score was derived by dividing the totals of those team member's 2008 Exit Level Science TAKS scores by 3 and allocating that number to each team member respectively.

Levene's Test for Equality of Variances was not significant for any of these seven outcome variables when contrasted with cooperation status. Independent sample t-tests were conducted to compare these outcome variables with cooperation status. There were 13 teams that were classified as cooperators, and 16 teams were non-cooperators. Level of significance for the t-tests was set a priori at .05.

Effect sizes were calculated for significant t-test results. Effect size, identified by the acronym ES, is a descriptive measure of the differences detected by these t-tests. The definition of effect size (Cohen's d statistic) is the difference between two means divided by the standard deviation of the data. In this study, the standard deviations of the data were pooled. Pooling the standard deviation is a common research practice (Rosnow & Rosenthal, 1996).

Although effect size is a derived number, descriptive terms such as small, medium, or large can be helpful when used to quantify ES. Cohen (1988, 1992) suggests the following guidelines for effect size in social science research: “small, d = 0.2; medium, d = 0.5; large, d = 0.8” (Cohen, 1988, p. 25).

“The terms ‘small,’ ‘medium,’ and ‘large’ are relative, not only to each other, but to the area of behavioral science or even more particularly to the specific content and research method being employed in an given investigation….In the face of this relativity, there is a certain risk inherent in offering conventional operational definitions for these terms used in power analysis in as diverse a field of inquiry as behavioral science. This risk is nevertheless accepted in the belief that more is to be gained than lost by supplying a common conventional frame of reference which is recommended for use not only when no better basis for estimating the ES index is available” (Cohen, 1988, p. 25). This measure of the magnitude of effect size (ES) is appropriate for quantitative research of this nature (Kotrlik & Williams, 2003).

Data from each group was analyzed using the SPSS 16.0 software package. Relationships between standard deviations among variables were investigated for evidence of statistical significance. Statistical significance was set at the a priori .05 level. Significant findings were compared to previous research.

A series of Pearson’s product moment correlations were conducted to detect relationships between cooperator status and variables derived from the questionnaire. Significance was set at the .05 level. Correlations between demographic variables and descriptive variables are included. Miller (1994) posits that the Davis convention regarding effect size is applicable to research in agricultural education. The Davis convention is employed in all cases to report correlations as being low, moderate, substantial, or other appropriate adjective.

To facilitate comparisons, several composite variables were constructed from the survey data. The variables constructed were Total Number of Agricultural Science Courses taken, Total Number of Agricultural Mechanics Courses Taken, Total Number of Mathematics Courses Taken, Total Number of Basic Mathematics Courses Taken, Total Number of Contextual Mathematics Courses Taken, Total Number of Higher Mathematics Courses Taken, Total Number of Science Courses Taken, Total Number of Basic Science Courses Taken, and Total Number of Contextual Science Courses Taken. A description of the content of each of these composite variables follows.

The Total Number of Agricultural Science Courses Taken was the sum of all agricultural science courses identified in Question 1 by the respondent. The maximum number of courses that could be identified was 16. The Total Number of Agricultural Mechanics Courses Taken included Introduction to Agricultural Mechanics, Agricultural Structures, Welding, Ag Power, Ag Mech Lab, Ag Electronics, Home Maintenance, and Tractor Lab. The maximum number of agricultural mechanics courses a respondent could select was 8.

The Total Number of Mathematics Courses Taken was the sum of all mathematics courses identified in Question 4. The maximum value for this variable was 9. The Total Number of Basic Mathematics Courses Taken included Algebra I, Algebra II, and Geometry, and had a maximum value of 3. The Total Number of Contextual Mathematics Courses Taken included Mathematical Models with Applications, and had a maximum value of 1. The Total Number of Higher Mathematics Courses Taken included Pre-calculus, Pre-AP Calculus, AP Calculus, and AP Statistics, and had a maximum value of 4. The mathematics course classified as Other was a catch-all category, and data from this choice was not included in the analysis due to ambiguity.

The Total Number of Science Courses Taken was the sum of all science courses identified by the respondent in Question 11. The maximum value for this variable was 8. The Total Number of Basic Science Courses Taken included Biology I, Physics, Chemistry, and Integrated Physics and Chemistry (IPC), and had a maximum value of 4. The Total Number of Contextual Science Courses Taken included Principles of Technology, Human Anatomy & Physiology, and AP Environmental Science, and had a maximum value of 3. The Total Number of Higher Science Courses Taken included AP Physics, and had a maximum value of 1.

## GENERAL DESCRIPTION OF POPULATION

There were 1,271,344 students enrolled in 1,704 Texas high schools in the 2006 – 2007 school year, 27.1% of the total K-12 student population. Hispanic students accounted for 46.6% of all students, 35.7% were European American, 14.4% were African American, and 3.6% of the student population were classified as ‘other.’ Statewide, 77% of the student population was classified as meeting the TAKS Mathematics standard, and 71% of the student population met the TAKS science standard (TEA, 2007). There were 941,045 students enrolled in career and technical education; this total represents 20.6% of the total K-12 school population. There were 241,193 public high school graduates in 2006 – 2007.

Approximately 120,000 students were enrolled in secondary agriculture, food and natural resources courses in Texas in 2006 – 2007. Of these, 75,000 (63%) were Caucasian, 32,300 (27%) were Hispanic, 10,750 (9%) were African American, 1,200 (1%) were Asian, and 570 (0.5%) were identified as Native American (Lavergne, 2008). Some 40,800 (34%) were female. These totals represent duplicated enrollment figures.

The target audience for this study was composed of students enrolled in power, structural and technical systems courses in secondary schools in Texas. According to 2003 – 2004 PEIMS data, enrollment in power, structural & technical systems-related courses exceeded 50,000 students annually. These students will be most directly impacted by results of this research due to teacher exposure to the problem sets developed in the process. The competitive selection process for the Agricultural Mechanics CDE was used to select the sample, preventing the random assignment of subjects to treatment groups.

## DESCRIPTION OF SAMPLE

Schools competing in the 2007 Texas FFA Agricultural Mechanics Career Development Event (April 2007, n = 30) were given the opportunity to participate in the study, and comprised the sample population. The 30 teachers with teams competing in the 2007 event were asked to indicate their interest in participating in a research study involving contextual mathematics. Of those 30 teachers, 27 (90%) answered in the affirmative. All 30 schools were again contacted by letter in the fall of 2007 and asked to return an information sheet indicating their interest in participation. The information sheet also provided the respondent with the opportunity to decline participation, or to secure further information and clarification. After 25 teachers responded to the initial mailing, the current Directory of Agricultural Science Teachers in Texas was consulted to determine if any teachers had changed schools during the summer of 2007. This was done to determine whether the mailings were going to the correct individual. Following the responses to a second mailing, the list was refined, and five schools were excluded because the teachers had changed schools. A total of 17 schools expressed interest, and had students who met the qualifications after the third mailing, while eight schools failed to respond.

The data provided by the TAKS Exit-level Mathematics and Science scores of the 30 schools in the sample population was compared with TAKS results statewide. The State Agricultural Mechanics CDE scores of these 30 schools were obtained from Ewell & Associates, a public information source. TAKS Exit-level Math and Science scores of those thirty school districts were obtained either from the school district offices, the district website, or Pearson Educational Measurement, Inc., a public information source.

## SELECTION OF SAMPLE

The Texas FFA Agricultural Mechanics Career Development Event was used to select the participants for this study. In this CDE, each FFA Chapter is eligible to enter one team at the Area level. Teams may include three or four members. Teams with four members have an advantage. There are 10 FFA Areas in Texas. Each Area is allowed to qualify three teams for the state event. The State competition is held in Huntsville each April, and is composed of the top 30 teams state-wide. A maximum of 120 secondary students may compete in this event annually. The winning team advances to the National FFA Agricultural Mechanics CDE, held in October, in Indianapolis, IN. The structure of the Texas State event closely parallels the National event.

The Agricultural Mechanics Career Development Event is a themed event. Each event is composed of three distinct sections; a written exam, three individual student skill activities, and a team activity. The theme for the 2007 event was materials handling. An assessment of the 2007 written examination indicated that of the 100 questions on the examination, 43 were mathematics problems (Appendix J). The theme for the 2008 event was poultry processing. An assessment of the 2008 written examination indicated that 51 of the 100 questions were contextual applications of mathematics (Larson, 2008). Students were provided graphing calculators for use with both the written examination and the team activity. Questions on the 2008 written examination were related to agricultural mechanics concepts applied in the poultry industry (Appendix K). These questions involved mathematics concepts such as percentages, measurements, sequences, computations, and understandings of the significance of numbers (Larson, 2008). These students also completed a survey instrument related to their use of graphing calculators in daily coursework.

The second section of the contest was composed of three individual skills-based activities. Still focusing on the poultry industry, the designated skills areas for 2008 were structures, energy, and equipment. The equipment used as an example for that skill area was the tractor-operated front-end loader. The energy skill centered on hydraulic pumps, motors, circuits, and controls. The structure skill focused on concrete applications.

The third section of the contest was a team activity. This section brought all aspects of the other components into a themed application problem (Appendix L). Event managers also provided students with graphing calculators for the team activity. The winner of the event was determined using the total scores of the top three members of each team. The event theme and the individual skill areas are determined approximately three years in advance at an annual meeting of the Texas FFA Agricultural Mechanics Committee. The committee is comprised of 20 secondary teachers, two selected from each FFA Area.

Schools from the original 2007 sample choosing to participate in the study comprised the experimental sample. Some of those schools qualified for the opportunity to participate in the 2008 State Agricultural Mechanics CDE. Since participation in the State CDE is competitive, the 30 teams competing in 2007 were not identical to the 30 competing in 2008. For a variety of reasons, the same schools may not choose to enter the Area agricultural mechanics CDE every year. Some school districts may change teachers, and the new teacher may choose not to train an agricultural mechanics CDE team. Students may become ill prior to the event, and not participate as effectively. Academically ineligible students may be removed from teams that usually qualify at the Area level. There are many reasons why the same team may not qualify for the State Agricultural Mechanics CDE two consecutive years.

The group of 116 students representing the 30 schools competing in the 2007 event was composed of five European American females (4.3%), one African-American male (0.86%), 14 Hispanic males (12.06%), two Asian American males, one male who self-reported ethnicity as Other and 96 European American males (82.75%).

The schools competing in the 2007 event and expressing interest in the mathematics enrichment activity were: Goldthwaite, North Lamar, A&M Consolidated, Kopperl, Floydada, Sandra Day O'Connor, Cameron Yoe, Abernathy, Saltillo, George West, Brownfield, Bellevue, Dawson County, Claude, Sonora, Grand Saline, Diboll, Bland, Callisburg, Corpus Christi Mary Carroll, Judson, Huckabay, Hillsboro, West Hardin County, Riviera Kaufer, and Bellville. Schools competing in the 2007 event but not expressing an interest in the mathematics enrichment activity at that time were Pilot Point, Lipan, and Burkeville.

The schools responding positively to the fall 2007 mailing were: Goldthwaite, A&M Consolidated, Kopperl, Floydada, Saltillo, George West, Bellevue, Grand Saline, Diboll, Bland, Judson, Hillsboro, West Hardin County, Pilot Point and Bellville.

Seven schools competed in the 2007 State CDE, but did not qualify to compete in the 2008 State Agricultural Mechanics CDE.  These schools were Sonora, Abernathy, Electra, Callisburg, Hillsboro, Bland, and Goldthwaite.  Bland agreed to be part of the study, but because they failed to qualify, they were unable to participate in the enrichment activity.  Goldthwaite and Hillsboro agreed to be part of the study and participated in the enhancement activities, but did not score high enough at the Area event to advance.  No TAKS Exit Mathematics scores were collected on these seven schools, and no survey data were collected from their students.

Schools with teams qualifying at the Area level to compete in the 2008 State Agricultural Mechanics Career Development Event were: North Lamar, A&M Consolidated, Kopperl, Glen Rose, Lipan, Floydada, Stony Point, Sandra Day O'Connor, Cameron Yoe, Saltillo, Era, Valley View, Pilot Point, George West, Brownfield, Hamilton, Bellevue, Dawson County, Panhandle, Claude, Wellman-Union, Grand Saline, Diboll, Burkeville, Corpus Christi Mary Carroll, Judson, Huckabay, West Hardin County, Riviera Kaufer, and Bellville.  The relationships among schools participating in the 2007 and 2008 State Agricultural Mechanics CDE are shown in Table 1.

*Table 1*

*Participants in the 2007 and 2008 state agricultural mechanics CDEs*

| School | Compete in 2007 | Interest in 2007 | Interest in 2008 | Cooperate in 2008 | Compete in 2008 |
|---|---|---|---|---|---|
| A&M C | Yes | Yes | Yes | Yes | Yes |
| Abernathy | Yes | Yes | No | No | No |
| Bellville | Yes | Yes | Yes | Yes | Yes |
| Bellevue | Yes | Yes | Yes | Yes | Yes |
| Bland | Yes | Yes | Yes | No | No |
| Brownfield | Yes | Yes | No | No | Yes |
| Burkeville | Yes | No | No | No | No |
| Callisburg | Yes | No | No | No | No |
| Claude | Yes | No | No | No | Yes |
| Dawson Co. | Yes | No | No | No | Yes |
| Diboll | Yes | No | Yes | Yes | Yes |
| Electra | Yes | No | No | No | No |
| Era | No | No | No | No | Yes |
| Floydada | Yes | Yes | Yes | No | Yes |
| George West | Yes | Yes | Yes | Yes | Yes |
| Glen Rose | Yes | No | No | No | Yes |
| Goldthwaite | Yes | Yes | Yes | Yes | No |
| Grand Saline | Yes | Yes | Yes | Yes | Yes |
| Hamilton | No | No | No | No | Yes |
| Hillsboro | Yes | Yes | Yes | Yes | No |
| Huckabay | Yes | Yes | No | No | Yes |
| Judson | Yes | Yes | Yes | Yes | Yes |
| Kaufer | Yes | Yes | No | No | Yes |
| Kopperl | Yes | Yes | Yes | Yes | Yes |

*Table 1 Continued*

| School | Compete in 2007 | Interest in 2007 | Interest in 2008 | Cooperate in 2008 | Compete in 2008 |
|---|---|---|---|---|---|
| Lipan | Yes | No | No | No | Yes |
| Mary Carroll | Yes | No | No | No | Yes |
| North Lamar | Yes | Yes | No | No | Yes |
| O'Connor | Yes | Yes | Yes | Yes | Yes |
| Panhandle | No | No | No | No | Yes |
| Pilot Point | Yes | No | Yes | Yes | Yes |
| Saltillo | Yes | Yes | Yes | Yes | Yes |
| Sonora | Yes | Yes | No | No | No |
| Stony Point | Yes | No | No | No | Yes |
| Valley View | No | No | No | No | Yes |
| Wellman | Yes | No | No | No | Yes |
| West Hardin | Yes | Yes | Yes | Yes | Yes |
| Yoe | Yes | Yes | No | Yes | Yes |

*Note:* Schools identified 'Cooperate in 2008' participated in the enrichment activity.

## DESCRIPTION OF TREATMENT

Five mathematics enrichment activities were developed that focused on power, structural and technical systems in relation to poultry processing (Larson, 2007). Students engaged in problem solving activities designed to be solved using graphing calculators. Problem sets and related instructional materials were provided to the participating schools at no cost. These materials were made available to participating schools prior to the training sessions. The method used was based on the imbedding strategy advocated by Bottoms, Presson and Johnson (SREB, 1992). The problem set was developed by a curriculum specialist and a mathematics consultant. A copy of the problem sets used can be found in Appendix A.

These enrichment activities were field-tested for suitability on teacher groups in a variety of venues. The venues included two national, two state, and four regional teacher professional development conferences over a period of 18 months. This was done to determine teacher familiarity with contemporary mathematics concepts and provide a professional development opportunity for teachers. To increase the fidelity of the treatment, at each venue situations that might impact future field-tests were noted, and adjustments were made.

These enrichment activities addressed several TAKS Exit-level Mathematics Assessment objectives. The objectives addressed were Objective 1: describing functional relationships (two problems); Objective 3: understanding linear functions; Objective 9: understanding percents, proportional relationships, probability and the application of statistics, and Objective 10: understanding mathematical tools and processes (Texas Education Agency, 2003). Susan Larson, mathematics consultant and member of the original 1996 TEKS writing team, evaluated the problem sets for congruence with the TAKS objectives. All four of these objectives were tested on the 2007 TAKS Exit-level Mathematics Assessment. Approximately 57% of the questions related to Objective 1 were answered correctly least 70% of the time. Approximately one-third of the TAKS assessment questions related to Objective 3 were answered correctly least 70% of the time (Silvey, 2007). These objectives were also identified by Heller, Curtis, Jaffe and Verboncouer (2005) as Algebra I topics that can be effectively taught using graphing calculators.

## APPLICATION OF THE TREATMENT TO THE SAMPLE

Enrichment activity sessions were conducted beginning in mid-March and continued until immediately before the CDE. These sessions were held in a variety of settings, ranging from all students in one class period, to single class periods with diverse student groups, to multiple class periods of agricultural science students, and to one session with students from multiple schools. Training was delivered to teachers and students. This process served as the experimental treatment, and introduced an independent variable.

There were threats to the fidelity of the treatment. One treatment session was cancelled due to an accident resulting in the tragic death of a student and injury of a second student, both of whom had qualified for State-level competition. This school's data were moved to the control group.

Institutional Review Board requirements were met. During the treatment sessions, participants and teachers were given student and parental permission / TAKS score release forms, and asked to bring the signed forms to the State Agricultural Mechanics CDE. When all teams qualifying to participate in the CDE had been identified, teachers received copies of student and parental permission / TAKS score release forms electronically. Completed forms were collected during the examination component of the CDE. Examples of student and parental permission / TAKS score release forms are found in Appendices B and C.

In these sessions, each participating student was provided with a TI 84+ graphing calculator and a problem set. Each problem was presented, solved by using the graphing calculator, and discussed before moving to the next problem. Teachers were present during the treatment sessions. Each teacher was provided with additional copies of the problem sets, and an answer key that outlined the steps in solving each problem. Demonstrating the problems to the teachers and leaving copies of the answer keys provided a level of professional development for the teachers in addition to enhancing student skills. A copy of the teacher's answer key is found in Appendix I.

The 15 schools participating in mathematics enhancement sessions were A&M Consolidated, Kopperl, Sandra Day O'Connor, Cameron Yoe, Saltillo, Hillsboro, Pilot Point, George West, Bellevue, Goldthwaite, Grand Saline, Diboll, Judson, West Hardin County, and Bellville. Two of these schools did not place high enough at their respective Area CDEs to advance to the State event. The 13 schools who qualified to compete in the State CDE, and therefore comprised the treatment group, were A&M Consolidated, Kopperl, Sandra Day O'Connor, Cameron Yoe, Saltillo, Pilot Point, George West, Bellevue, Grand Saline, Diboll, Judson, West Hardin County, and Bellville.

## DATA COLLECTION METHODS

Data for this study were collected using three different methods. The first data collection method consisted of a written questionnaire administered to students participating in the 2008 State Agricultural Mechanics CDE. The questionnaire was administered only on the day of the State Agricultural Mechanics CDE. There were therefore no early or late responders. Some respondents failed to answer all of the questions on the survey instrument, but no follow up methods were possible.

The second data collection method was the State Agricultural Mechanics CDE. Data collected included individual and team scoring data of all students. This information was accessed electronically the week following the CDE from the Judgingcard.com web site of Ewell and Associates. This information is publicly available.

The third data collection method included gathering the TAKS Exit-level Mathematics and Science scores of cooperator and non-cooperator students and schools. Using a modified Dillman technique, participating school districts were given seven opportunities to submit their Exit-level Mathematics and Science TAKS scores (Dillman, 1978). After seven requests, scores obtained from the Pearson Educational Assessment website were used for districts failing to submit their Exit-level Mathematics and Science TAKS scores. Six school districts failed to submit their scores in a timely manner. School districts were asked to submit score results for all students tested.

Statewide TAKS Exit-level Mathematics and Science scores are publicly available on the Texas Education Agency web site.

## SURVEY INSTRUMENT DATA

The written questionnaire was administered following the written examination of the State CDE on April 25, 2008. A data coding sheet was developed to facilitate data entry of the responses of this questionnaire. This data coding sheet is included as Appendix G.

Student responses to this 25 item questionnaire comprised the first data source. The survey instrument was developed with assistance of agricultural mechanics technical experts, a mathematics consultant, and the Texas Instrument Ag Prep Academic Coordinator. Content and face validity of the instrument were established by a panel of experts consisting of university faculty, technical experts, and contest judges. Minor wording and formatting changes were made based on recommendations of the panel.

A pilot test of the instrument was conducted during the Area III and VII Agricultural Mechanics CDEs. In all, 59 students completed the pilot instrument. A reliability test on items 1 - grade enrolled, 7 – frequency of graphing calculator use, 11 – frequency of participation in agricultural mechanics CDEs, and 12 – self-reported mathematics grade, was conducted on the instrument. The Chronbach’s Alpha score for these four items was .44. Reliability of the instruments was limited due to the small number of scaled items.  Changes were made to the instrument based on the results of the pilot test.  These four items were item 21 – grade enrolled, 6 – frequency of graphing calculator use, 14 – frequency of participation in agricultural mechanics CDEs, and 10 – self-reported mathematics grade on the student questionnaire administered at the 2008 State Agricultural Mechanics CDE.

Students participating in the 2008 Agricultural Mechanics CDE (n = 109) were asked to complete the demographic survey instrument following the written examination portion of the CDE.  A total of ninety-nine (99) usable instruments were returned.  Data from these 99 usable surveys were examined for the findings of the study.  A copy of the questionnaire is included as Appendix D.

Question 1 of the survey instruments asked respondents to identify the agricultural science classes in which they had enrolled.  Fifteen agriscience course choices and an Other choice were available.  The item included were based on the classes with the highest enrollments reported in recent PEIMS data (Texas Education Agency, 2005).

Question 2 asked respondents to indicate the extent to which the agricultural mechanics CDE was related to their secondary agricultural science instruction.

Question 3 of the survey instrument asked respondents to identify a career pathway, or category, which most closely described his/her career choice.  Choices available were the seven career pathways for agriculture, food and natural resources (National Association of State Directors of Career Technical Education Consortium, 2003).  Two pathways reflective of the secondary agriculture, food and natural resources curriculum in Texas, were added on advice from university faculty. A tenth choice was included to provide respondents an Other option.

Question 4 asked respondents to identify the high school mathematics courses they had completed. Choices for mathematics courses were taken from the state-mandated graduation requirements (Texas Education Agency, 2007). Choices included Algebra I, Algebra II, Pre-calculus, Geometry, Mathematical Models with Applications, AP Calculus, AP Statistics, Pre-AP Calculus, and a choice for Other.

Several questions were designed to assess specific information regarding student use of graphing calculators. Question 5 asked respondents to indicate whether they used graphing calculators at school. Question 6 asked respondents to indicate the frequency of graphing calculator use at school. Descriptors available for selection were Daily, Weekly, Monthly, and As Required. Question 7 asked respondents to indicate their level of proficiency in using graphing calculators. Question 8 asked respondents whether they owned a graphing calculator. Question 9 asked respondents indicating graphing calculator ownership in Question 8 to indicate the brand of calculator owned.

Question 10 asked respondents to self-report their usual mathematics grade. Choices included A, B, C, and D due to no pass, no play academic eligibility rules. Students who were not passing all courses in the previous grading period were ineligible to compete in the agricultural mechanics CDE.

Question 11 asked respondents to indicate secondary science classes in which they had been enrolled. The choices were Principles of Technology, Biology I, Physics, Human Anatomy & Physiology, Chemistry, AP Physics, Integrated Physics and Chemistry, and AP Environmental Science (Texas Education Agency, 2007).

Question 12 asked respondents to estimate their team's final numerical placing in the CDE, from first to 30th place. Question 13 asked respondents to predict their individual numerical placing in the CDE, from first to 120th.

Question 14 asked respondents to report the number of agricultural mechanics CDEs in which they had participated. Four answer categories were provided; 1-3 CDEs, 4-6 CDEs, 7-9 CDEs, 10 or more CDEs.

Question 15 asked respondents to report previous participation in the Texas FFA Tractor Technician CDE.

Question 16 asked respondents to self-report their usual grade in agricultural mechanics courses. Choices available were A, B, C, and D.

Question 17 asked respondents to self-report their overall average grade or GPA. Choices available were A, B, C, and D.

Question 18, 19 and 20 asked respondents to identify the TAKS assessments they had completed. The timing of this survey impacted the responses to these items. The Math TAKS assessments for 2008, for all levels (9th, 10th, and Exit level), were administered the week following the State Agricultural Mechanics CDE.

Three questions were used to provide quantitative demographic data. Question 21 asked respondents to identify their grade level. Question 22 asked respondents to identify their gender. Question 23 asked respondents to identify ethnicity from a list of six choices.

To complete the survey, two questions addressed students' participation in performance fine arts activities. Question 24 asked respondents to indicate whether they had participated in band, orchestra, or choir. Question 25 asked respondents to identify the grade level of their participation in band, orchestra, or choir.

## CAREER DEVELOPMENT EVENT RESULTS DATA

Area career development event competitions began in early April 2008. The 2008 Texas FFA Agricultural Mechanics CDE was conducted April 25, 2008 in Huntsville, Texas. One team failed to arrive for the event. This school was originally assigned to the control group, and was removed. There were a total of 29 teams competing in the 2008 Agricultural Mechanics CDE.

The results of the individual and team final placings of schools competing in the 2008 (n = 29) State Agricultural Mechanics CDEs were collected. Students participating in this CDE were divided into two groups; a treatment group of teams receiving mathematics enrichment activities categorized as cooperators, and a control group of teams choosing not to receive mathematics enhancement, categorized as non-cooperators. Scores for written examinations, individual student skills, and team activities were compiled.

Students participating in the 2008 event were provided with graphing calculators for use during the written examination and team activity portions of this event. Three questions on the 2008 written examination were specifically designed to be solved using graphing calculators.

To test the differences between cooperators and non-cooperators, three outcome variables utilizing team performance data were developed to analyze the inferential statistics of this study. These variables were Average of Exam Scores, Team Activity Score, and Total CDE Score. The data entered into SPSS Survey. The Average of Exam Scores (AVGexamscore) was derived by summing the 3 highest written examination scores for each team, dividing by 3, and allocating this score to each respective team member. The Team Activity Score (ActivScore) was derived by dividing the activity score of each team by the number of team members (3) and allocating that number to each team member respectively. The Total CDE Score (TotCDEscore) was derived by dividing each team's total score by 3 and allocating that number to each team member respectively.

## EXIT-LEVEL TAKS ASSESSMENTS DATA

Three sets of exit-level TAKS mathematics and science scores were used to accomplish the purposes of this study. Those score sets were state TAKS scores, School TAKS scores, and Team TAKS scores.

Exit-level TAKS assessments for mathematics and science were administered statewide the week of April 30, 2008. The results of these statewide TAKS assessments were released to the respective school districts and campuses in late May 2008. These overall State Exit TAKS Mean Scores for both Mathematics and Science were used in comparisons. The disaggregated Exit TAKS Mean Scores for CTE students were also used in comparison to the statewide TAKS scores.

To test the differences between cooperators and non-cooperators, two outcome variables utilizing Exit TAKS Mathematics and Science mean score data from participating schools were developed to analyze the inferential statistics of this study. Campuses in the study were asked to submit their summary TAKS score reports. The Exit TAKS scores for Mathematics and Science from those 29 campuses were used to develop the School TAKS Mathematics (SchMATHscore) Score and School TAKS Science (SchSCIENCEscore) Score variables. Additionally, TAKS scores from the 29 schools competing in the State Agricultural Mechanics CDE were then compared to TAKS results statewide.

Participating schools were asked to provide the individual but anonymous student TAKS mathematics and science scores data for the members of each Agricultural Mechanics team. These individual scores were then combined and averaged into the Team TAKS Mathematics and Team TAKS Science scores. This was done to compare team level exit-level mathematics and science TAKS scores of those students participating in the event to school and statewide scores.

A modified Dillman technique was used to secure these Exit-level TAKS score data for these anonymous individual students. Beginning in mid-May 2008, principals of the 30 schools competing in the State Agricultural Mechanics CDE were mailed written requests for individual student TAKS scores. Each principal was provided with an information sheet explaining the study and copies of both student and parental confidential TAKS score releases. As schools returned the requested information, scores were entered into SPSS in a tabular format. Schools responding to the data request were removed from the list, and subsequent mailings were sent to the remaining schools. A series of six requests were sent. Examples of the principal request letters and information letters are included in Appendices E and F.

Gathering this individual but anonymous student data from all participating schools proved to be difficult. Individual, anonymous student data were provided by 12 cooperators and 7 non-cooperators, for a total of 19 schools. Schools furnishing these data were A&M Consolidated, Belleville, Bellevue, Claude, Diboll, Floydada, George West, Grand Saline, Hamilton, Judson, Kaufer, Kopperl, Mary Carroll, North Lamar, Pilot Point, Saltillo, Valley View, West Hardin, and Yoe.

Non-respondent schools were identified at the end of the mailing period, and TAKS Exit scores were extracted from Pearson Educational Assessment, Inc. and utilized for these schools. Campus-wide score reports for All Students Tested were used to satisfy data requirements for schools not responding to the data request. These score reports from Pearson Educational Assessment and the anonymous individual data provided by school districts were used to construct the variables Team TAKS Mathematics Score and Team TAKS Science Score.

In conclusion, to accomplish the purposes of this study, three sources of data were used. Survey data were used to explore relationships among and between groups of students sharing particular characteristics. Composite outcome variables were created from CDE results data and TAKS scores data to serve as outcome variables. The performance of cooperators and non-cooperators on these outcome variables were used to determine whether the effects of an enrichment activity significantly impacted student mathematics performance in either the agricultural mechanics career development event or the TAKS exit mathematics or science assessment.

# CHAPTER IV

# FINDINGS

## INTRODUCTION

This chapter contains the research findings focused on the questions of the study. The research findings were taken from three distinct data sources; a demographic and informational survey of participants conducted on the day of the State Agricultural Mechanics CDE, the results of the State Agricultural Mechanics CDE, and the TAKS assessment scores for individual participants, teams, and the state as a whole.

This chapter will present the findings in the following manner. A description of the sample will be provided, followed by a description of the treatment sessions, and a description of process for addressing non-response issues. The questions raised in the statement of the problem will be presented as four research objectives. For each research objective, the descriptive findings relative to that objective will be presented and followed by the inferential findings relative to that objective. A summary of the findings is placed at the end of the chapter. The research objectives are restated below.

Objective 1 was to describe the participants in the study and their responses to items on the questionnaire, and explore the relationships between the participants' demographic characteristics and interrelated items on the survey instrument. The findings are organized in the order the items were posed in the questionnaire (Appendix D).

Objective 2 was to compare CDE Contest outcomes; the Written Examination, Team Individual Skill scores, and Team Activity scores between teams exposed to mathematics enrichment activities and those that were not.

Objective 3 was to compare Team TAKS Mathematics and Science scores, School TAKS Mathematics and Science scores, Team Composite State Agricultural Mechanics CDE scores, perceived level of expertise with a graphing calculator, and frequency of participation in CDEs between teams exposed to contextual mathematics enrichment activities and those that were not.

Objective 4 was to explore interrelationships between Team TAKS Mathematics scores, Team Composite State Agricultural Mechanics CDE scores, and participation in fine arts courses between students exposed to contextual mathematics enrichment activities and those that were not.

## GENERAL DESCRIPTION OF THE SAMPLE

Thirty teams qualified to participate in the 2008 Texas State Agricultural Mechanics CDE, conducted in April 2008. Of this number, 29 teams competed in the CDE. A total of 109 students on these 29 teams participated in the CDE. From the 109 CDE participants, 100 survey instruments were obtained on the day of the event. One survey response was discarded due to the respondent's failure to answer any of the items, resulting in 99 usable survey instruments (90.8%). Data from these 99 usable instruments were analyzed using descriptive and correlational techniques.

The group of 99 students was composed of 5 European American females (5.1%), 1 African-American male (1.0%), 10 Hispanic American males (10.1%), 2 Asian American males (2%), and 66 European American males (66.7%). One male respondent self-identified his ethnicity as Other (1%). Fourteen students did not respond to the question. These gender and ethnicity data are presented in Table 2.

*Table 2*

*Gender and ethnicity of participants (n = 99)*

| | Females | Males |
|---|---|---|
| European American | 5 | 66 |
| African American | | 1 |
| Hispanic American | | 10 |
| Asian American | | 2 |
| Other | | 1 |
| No response | | 14 |

Description of Treatment and Control Groups

In this study, 43 (43.43%) of the respondents participated in enrichment activities and comprised the treatment group. The control group was comprised of 56 respondents who did not participate in enrichment activities (56.57%). Of these 56 respondents in the control group, 33 respondents were on teams that participated in both the 2007 and 2008 CDEs, and 23 respondents participated in the 2008, but not the 2007 CDE.

## Description of Schools Participating in the 2008 State Agricultural Mechanics CDE

Schools participating in the 2008 State Agricultural Mechanics CDE were described according to cooperator status, accreditation status, enrollment size, mathematics acknowledgements based on 2007 Texas Education Agency Academic Excellence Accountability System (AEIS) data, and geographic location. The 2007 timeframe was used to mirror the selection criteria; i.e. groups participating in this study were selected based on participation in the 2007 State Agricultural Mechanics CDE. Enrollment size is based on 2008 – 2010 University Interscholastic League (UIL) (2008) alignments; this data reflects school enrollment at the time of participation in the 2008 Agricultural Mechanics CDE. No schools participating in the 2008 State Agricultural Mechanics CDE had received acknowledgments for TAKS Science score improvements. Geographic location is identified by FFA Area designation, and a map is included as Appendix H. Size, academic performance, and mathematics emphasis descriptions of the schools participating in the 2008 Agricultural Mechanics CDE are provided in Tables 3 and 4.

*Table 3*

*Description of schools identified as cooperators (n = 13)*

| School number | Cooperator Status | 2007 Accreditation | UIL Size | Mathematics Acknowledgements | FFA Area |
|---|---|---|---|---|---|
| 1 | Yes | AA | 5A | | 3 |
| 2 | Yes | AA | A | | 4 |
| 3 | Yes | AA | 3A | TSI | 3 |
| 4 | Yes | AA | 3A | | 9 |
| 5 | Yes | AA | 2A | | 10 |
| 6 | Yes | AA | 2A | CI | 6 |
| 7 | Yes | AA | 5A | | 7 |
| 8 | Yes | AA | A | TSI | 8 |
| 9 | Yes | AA | 5A | TSI | 7 |
| 10 | Yes | AA | 2A | TSI | 5 |
| 11 | Yes | AA | A | TSI | 6 |
| 12 | Yes | AA | A | | 9 |
| 13 | Yes | AA | 3A | | 3 |

*Note:* Teams are identified by numbers 1 though 13. Cooperator status is characterized as Yes. Accreditation Status in 2007 is indicated by acronyms explained in the Glossary of Terms. UIL Size (A – 5A) is based on secondary school enrollment. Mathematics Acknowledgements (C, CI, TSI) are based on AEIS data, and explained in the Glossary of Terms.

*Table 4*

*Description of schools identified as non-cooperators (n = 16)*

| School number | Cooperator Status | 2007 Accreditation | UIL Size | Mathematics Acknowledgements | FFA Area |
|---|---|---|---|---|---|
| 14 | No | AU | 3A | | 2 |
| 15 | No | R | A | TSI | 1 |
| 16 | No | AA | A | TSI, CI | 2 |
| 17 | No | AA | 2A | TSI, CI | 1 |
| 18 | No | AA | A | TSI, CI | 4 |
| 19 | No | AA | 2A | | 10 |
| 20 | No | AA | A | CI | 8 |
| 21 | No | AA | 5A | CI | 10 |
| 22 | No | AA | 3A | TSI | 6 |
| 23 | No | R | A | TSI, C | 5 |
| 24 | No | AA | 3A | | 8 |
| 25 | No | AA | 2A | TSI | 4 |
| 26 | No | R | 2A | TSI | 1 |
| 27 | No | AA | 5A | | 7 |
| 28 | No | R | 2A | TSI | 2 |
| 29 | No | AA | 2A | TSI | 5 |

*Note:* Teams are identified by numbers 14 though 29. Cooperator status is characterized as No. Accreditation Status in 2007 is indicated by acronyms explained in the Glossary of Terms. UIL Size (A – 5A) is based on secondary school enrollment. Mathematics Acknowledgements (C, CI, TSI) are based on AEIS data, and explained in the Glossary of Terms.

Description of the Agricultural Mechanics CDE

There were 30 teams that qualified for the 2008 Texas State Agricultural Mechanics CDE. Of this number, 29 teams competed in the CDE. One team failed to show up at the CDE site. For this study, the teams were divided into two groups. The 13 teams in the treatment group, characterized as cooperators, participated in both the 2007 and 2008 State Agricultural Mechanics CDE and the mathematics enrichment activity. The control group, composed of 16 teams characterized as non-cooperators, chose not to participate in the mathematics enrichment activity. All these teams competed in the 2008 State Agricultural Mechanics CDEs. Some participated in both the 2007 and the 2008 CDE.

The State Agricultural Mechanics CDE is a themed event composed of three distinct components; individual skills, a team activity, and a written examination. The maximum possible score per team is 695, and the maximum possible score per individual is 232.

The maximum possible score on the written examination is 100 points. The maximum allowable score on the team activity is 125 points. Each member of the team is allocated 1/3 of the team's score on this portion of the CDE, regardless of whether the team is composed of 3 or 4 members. The perfect score for one individual's portion of the team activity is 42 points. There are 3 individual student skills activities included in the CDE each year. The maximum possible score on the individual student skills activity is 30 points per skill, for a maximum of 90 points per student. Teams are scored based on total number of points per team of three students, and ranked inversely based on total points (Blaha, 2005). A team with a higher total number of points is allocated a lower numerical ranking; the school with the highest total score is ranked 1st .

To develop the written examination, a pool of approximately 150 potential examination questions is generated each year by selected agricultural science faculty members from across the state involved with the Agricultural Mechanics Career Development Event. This pool is narrowed to the final examination consisting of 100 objective questions. An analysis of the mathematics content of the questions on the 2007 and 2008 written examinations is included in Chapter III. Students have approximately 60 minutes to complete the written examination, and record their answers on machine-scored forms. Average score on the written examination was 63.02 in 2007 and 62.73 in 2008.

The National FFA Agricultural Mechanics Career Development Event is divided into five distinct systems or emphasis areas. Those systems are Machinery and Equipment, Industry and Marketing, Energy, Structures, and Environmental – Natural Resources. The Texas Agricultural Mechanics Committee identifies three of these areas for development of the individual skills component of the state CDE. Each student is scored on performance of a specific skill in each of the three systems areas selected for inclusion that year. The specific skills are not publicized before the event, but the committee does narrow the system content. The three skills systems selected for 2008 were machinery and equipment: front-end loaders; structures: concrete; and energy: hydraulic pumps, motors, cylinders and controls. Each participant has 20 minutes to complete each of the skill activities. In the 2008 CDE, the mean individual skill score of cooperators was 44.52; mean individual skill score for non-cooperators was 37.55. An independent samples t-test yielded these results ($p$ = .054). These means were not significantly different.

The theme of the State Agricultural Mechanics CDE is identified the summer prior to each year's event. The theme identified for the 2008 CDE was poultry processing. The 2008 Team Activity was couched in a problem requiring calculation of water consumption and ventilation requirements for large broilers. Each team of three or four members has 60 minutes to complete the team activity. Average score on the team activity was 25.36 in 2007 and 26.46 in 2008.

Total team scores in the Agricultural Mechanics CDE are calculated by adding the scores of each student's written examination, three individual skills, and team activity. Teams are then ranked from highest to lowest based on total team score. Average team score on the 2007 CDE was 394.18, and average score in 2008 was 391.55. Results of the CDE scores by year are displayed in Table 5 and Table 6.

*Table 5*

*Analysis of 2007 agricultural mechanics CDE scores (n = 29)*

| Descriptor | Minimum | Maximum | *m* | Maximum Possible |
|---|---|---|---|---|
| Exam score | 51.25 | 71.75 | 63.10 | 100.00 |
| Activity score | 17.00 | 37.00 | 25.36 | 125.00 |
| Team total score | 306.00 | 466.00 | 394.18 | 695.00 |

*Table 6*

*Analysis of 2008 agricultural mechanics CDE scores (n =29)*

| Descriptor | Minimum | Maximum | *m* | Maximum Possible |
|---|---|---|---|---|
| Exam score | 44.31 | 80.00 | 62.73 | 100.00 |
| Activity score | 7.00 | 39.00 | 26.46 | 125.00 |
| Team total score | 282.00 | 504.00 | 391.55 | 695.00 |

## DESCRIPTION OF TREATMENT SESSIONS

The treatment group consisted of schools choosing to participate in an enrichment activity training session. This training session introduced the experimental variable. Schools choosing to cooperate in the study and host an enrichment activity were coded 1 in the SPSS data layout. Schools choosing not to host an enrichment activity or not competing in the 2007 State Agricultural Mechanics CDE were coded 2 in the SPSS data layout.

## TREATMENT OF NON-RESPONDENTS

No effort was made to control for non-response error in this study. Survey data were collected in a single setting. It was not possible to contact students who failed to complete the surveys without violating the anonymity of the survey responses.

## RESEARCH OBJECTIVE 1

The first research objective was to describe the participants in the study through analysis of the descriptive findings based on the questionnaire, and explore the relationships between the participants and interrelated items contained in the instrument.

There were 29 teams that participated in the State Agricultural Mechanics CDE on April 24, 2008. Students competing in the CDE were asked to complete a 25-item questionnaire after finishing the written examination. Frequencies and means of these team responses to the questionnaire were examined. A copy of the survey instrument is provided as Appendix D.

Objective 1A – Analyses of Survey Response Data

Question 1 –Respondents were asked to identify the agricultural science classes in which they had enrolled. Frequencies were tabulated for the number of students who had taken each of the agricultural science classes. All students had taken at least one agricultural science class. Students may take more than 1 course; many students may have selected more than 1 class on the survey. These data are summarized in Table 7.

*Table 7*

*Agricultural science class enrollment frequencies (n = 99)*

| Name of class | *f* | Percent (%) |
|---|---|---|
| Intro to Agricultural Science | 79 | 79.8 |
| Applied Agr. Science | 21 | 21.2 |
| Intro to Agricultural Mech. | 67 | 67.7 |
| Wildlife & Rec. Mgmt. | 34 | 34.3 |
| Plant & Animal Science | 28 | 28.3 |
| Introduction to Horticulture | 13 | 13.1 |
| Pers. Skills Development | 6 | 6.1 |
| Agricultural Structures | 26 | 26.3 |
| Metal Fabrication | 56 | 56.6 |
| Agricultural Power Tech. | 22 | 22.2 |
| Agricultural Mechanics Lab | 39 | 39.4 |

*Table 7 Continued*

| Name of class | *f* | Percent (%) |
|---|---|---|
| Equine Science | 12 | 12.1 |
| Agricultural Electronics | 11 | 11.1 |
| Home Maintenance | 19 | 19.2 |
| Tractor Laboratory | 8 | 8.1 |
| Other Ag class | 33 | 33.3 |

Question 2 – Respondents were asked to indicate the degree of relatedness between the agricultural mechanics CDE and their secondary agriscience instruction. Fully two-thirds of the respondents reported that instruction received in the agricultural science classroom was related to the CDE; half of the respondents reported that the instruction received was directly related. These data are summarized in Table 8.

*Table 8*

*Relationship between agricultural mechanics CDE and secondary agriscience instruction (n = 99)*

| Descriptor | *f* | Percent (%) |
|---|---|---|
| Directly | 50 | 50.5 |
| Indirectly | 20 | 20.2 |

*Table 8 Continued*

| Descriptor | *f* | Percent (%) |
|---|---|---|
| Little relation | 24 | 24.2 |
| No relation | 3 | 3.0 |
| Missing | 2 | |

Question 3 – Respondents were asked to identify a career pathway, or category, which most closely described his/her career choice. Choices available were the seven career pathways for agriculture, food and natural resources, two pathways similar to contemporary college majors in agriculture, and one choice for other / undecided (National Association of State Directors of Career Technical Education Consortium, 2003). Almost 40% of respondents identified power, structures and technical systems as their preferred career choice, and slightly more than one-third were undecided. Both groups identified power, structural and technical systems as their most popular career pathway; the cooperator mean was 7.05 and the non-cooperator mean was 6.95. Frequencies were tabulated on the career pathways selected by respondents. Summaries of the data are provided in Table 9.

*Table 9*

*Pathway that best describes respondent's career choice (n = 99)*

| Pathway | *f* | Percent (%) |
|---|---|---|
| Food Products & Processing | 0 | 0 |
| Agribusiness Systems | 8 | 8.1 |
| Plant / Horticultural Systems | 1 | 1.0 |
| Animal Systems | 6 | 6.1 |
| Natural Resource Systems | 4 | 4.0 |
| Power, Structural & Technical Systems | 38 | 38.4 |
| Leadership Development | 4 | 4.0 |
| Communications Systems | 2 | 2.0 |
| Environmental Service Systems | 1 | 1.0 |
| Other / Undecided | 35 | 35.4 |
| Missing | 2 | |

<u>Question 4</u> – Respondents were asked to identify the high school mathematics courses they had completed. Choices for mathematics courses included Algebra I, Algebra II, Pre-calculus, Geometry, Mathematics Models with Applications, AP Calculus, AP Statistics, Pre-AP Calculus, and a choice for Other. Responses are not mutually exclusive; participants may have selected more than 1 response. Frequencies

were tabulated on the total number of mathematics courses completed by respondents. In excess of 80% of all participants had completed Algebra I, Algebra II, and Geometry. These were the three mathematics courses taken by the majority of high school students prior to the 4 X 4 requirement (Texas Education Agency, 2007). Slightly less than 1/3 had taken pre-calculus, and less than 1 in 10 reported taking a contextual mathematics course such as Mathematical Models with Applications, which is specifically identified as one an acceptable mathematics course in the current Texas recommended graduation plan (Texas Education Agency, 2007b). These data were summarized in Table 10.

*Table 10*

*High school mathematics classes completed (n = 99)*

| Descriptor | *f* | Percent (%) |
|---|---|---|
| Algebra I | 97 | 98.0 |
| Algebra II | 83 | 83.8 |
| Pre-calculus | 30 | 30.3 |
| Geometry | 94 | 94.9 |
| Math Models | 8 | 8.1 |
| AP Calculus | 8 | 8.1 |
| AP Statistics | 4 | 4.0 |
| Pre-AP Calculus | 11 | 11.1 |
| Other | 14 | 14.1 |

Question 5 – Respondents were asked to indicate whether they used graphing calculators at school; 95 (96%) indicted yes; 4 indicated no. The groups were not significantly different; both groups used graphing calculators at school.

Question 6 – Respondents were asked to indicate the frequency of graphing calculator use at school. Descriptors available for selection were daily, weekly, monthly, and as required. Frequencies were tabulated on the descriptor identified. The mean of responses for frequency of usage was 2.01. Almost 60% of the respondents use graphing calculators on a daily basis. A t-test was conducted ($p = .96$, $t = -.05$) and the means of the groups were not significantly different; both groups used graphing calculators equally. Frequency and percentage data were summarized in Table 11.

*Table 11*

*Frequency of graphing calculator use in a classroom setting (n = 99)*

| Descriptor | *f* | Percent (%) |
|---|---|---|
| Daily | 59 | 59.6 |
| Weekly | 9 | 9.2 |
| Monthly | 0 | 0 |
| As required | 30 | 30.3 |
| Missing | 1 | |

Question 7 – Respondents were asked to indicate their level of proficiency in using graphing calculators. Frequencies were tabulated on the descriptor identified by the respondent. The mean of level of frequency response was 2.61, indicating that the average student was between the Intermediate and Competent proficiency levels. Over 50% of the students described themselves as Competent or Expert users of graphing calculators. In excess of one-half of the respondents were at a "proficient" skill level. A t-test was conducted ($p$ = .70, $t$ = .40) and the means of the groups were not significantly different; the groups were similar in level of expertise level with graphing calculators. These data were summarized in Table 12.

*Table 12*

*Level of expertise with a graphing calculator in a classroom setting (n = 99)*

| Descriptor | *f* | Percent (%) |
|---|---|---|
| Novice | 8 | 8.1 |
| Intermediate | 31 | 31.3 |
| Competent | 52 | 52.5 |
| Expert | 8 | 8.1 |

Question 8 – Respondents were asked whether they owned a graphing calculator; 50 (50.5%) owned a graphing calculator, 49 did not. A t-test was conducted ($p$ = .98, $t$ = -.03) and the means of the groups were not significantly different; groups were similar in regards to graphing calculator ownership. This mirrors the findings of previous studies (Heller, Curtis, Jaffe & Verboncouer, 2005). It appears that graphing calculators will not achieve more than a 50% adoption rate by high school students.

Question 9 – Respondents who indicated that they owned a graphing calculator in question 8 were asked to indicate brand of calculator owned. Frequencies were tabulated on the calculator owned by the respondent. Of the 50 students that owned graphing calculators, almost half of that group owned a TI 83+, fully 70% owned calculators in the TI 83 / 84 model family, and 98% owned a TI graphing calculator. The state-wide adoption of TI calculators clearly influenced the purchasing decisions of high school students. These data are summarized in Table 13.

*Table 13*

*Brand of graphing calculator owned by respondent (n = 50)*

| Brand | *f* | Percent (%) |
|---|---|---|
| TI 83+ | 22 | 44 |
| TI 84+ | 12 | 24 |
| TI 83 | 4 | 8 |
| Casio | 4 | 8 |
| TI 82 | 2 | 4 |
| TI 86 | 2 | 4 |
| TI 89 | 2 | 4 |

*Table 13 Continued*

| Brand | *f* | Percent (%) |
|---|---|---|
| HP | 1 | 2 |
| Missing | 1 | |

Question 10 – Respondents were asked to report their expected grade in mathematics. Four responses were available; A, B, C, and D. The mean response for expected mathematics grade was 1.51. In excess of 95% of the respondents expected an A or a B in mathematics; Respondents were similar in average mathematics grade, and felt they were mathematically competent, and These data are summarized in Table 14.

*Table 14*

*Expected grade in mathematic courses (n = 99)*

| Grade | *f* | Percentage (%) |
|---|---|---|
| A | 52 | 52.5 |
| B | 42 | 42.4 |
| C | 4 | 4.0 |
| D | 0 | 0 |
| Missing | 1 | |

Question 11 – Respondents were asked to identify the high school science classes they had completed. Choices for science classes included Principles of Technology, Biology I, Physics, Human Anatomy & Physiology, Chemistry, AP Physics, Integrated Physics and Chemistry, and AP Environmental Science. Frequencies were tabulated on the science classes completed by respondents. The majority of respondents indicated having completed Biology I, Chemistry, and Integrated Physics and Chemistry. These represent the most popular science courses prior to the institution of the 4 X 4 graduation plan (Texas Education Agency, 2007). The total percentage of students enrolled in the three contextual science courses barely exceeds 20%; agricultural science as a contextual science area, is at a competitive disadvantage. These data are summarized in Table 15.

*Table 15*

*High school science classes completed (n = 8)*

| Descriptor | *f* | Percent (%) |
|---|---|---|
| Principles of Technology | 5 | 5.05 |
| Biology I | 80 | 80.8 |
| Physics | 27 | 27.2 |
| Anatomy & Physiology | 14 | 14.14 |
| Chemistry | 64 | 64.6 |
| AP Physics | 6 | 6.06 |
| Int. Physics & Chemistry | 51 | 51.5 |

*Table 15 Continued*

| Descriptor | *f* | Percent (%) |
|---|---|---|
| AP Environmental Science | 1 | 1.01 |
| Missing | 0 | |

Question 12 – Frequencies and percentages were calculated for the respondents' anticipated final placing of their respective team. Teams are placed first through 30th, based on a combination of exam scores, individual skills scores, and team activity scores. The mean anticipated team placing was 8.32. Some 38% of team members expected their teams to place in the top 5. The most commonly occurring predicted team placings were first, fifth, and fifteenth. These data are summarized in Table 16.

*Table 16*

*Estimates of team final placing (n = 99)*

| Team placing | *f* | Percent (%) |
|---|---|---|
| 1 | 13 | 13.1 |
| 2 | 4 | 4.0 |
| 3 | 2 | 2.0 |
| 4 | 2 | 2.0 |
| 5 | 17 | 17.2 |

*Table 16 Continued*

| Team placing | *f* | Percent (%) |
|---|---|---|
| 6 | 2 | 2.0 |
| 7 | 1 | 1.0 |
| 8 | 3 | 3.0 |
| 9 | 3 | 3.0 |
| 10 | 8 | 8.1 |
| 14 | 1 | 1.0 |
| 15 | 12 | 12.1 |
| 20 | 4 | 4.0 |
| 25 | 2 | 2.0 |
| 30 | 1 | 1.0 |
| Missing | 24 | |

Question 13 – Means and standard deviations were calculated for the respondents' anticipated individual placing on a team basis. Means and standard deviations were not reported on teams with only one response. One team recorded no responses to this question. Files were split based on number of respondents per team. The mean anticipated individual placing was 28.34. Anticipated individual placings with the highest means were fourth, seventeenth, twenty-fourth, and thirty-ninth. Many career development events will provide awards for the top five or top 10 high-point individuals. These data were summarized in Table 17.

*Table 17*

*Estimate of individual final placing (n = 95)*

| Team | *m* | *sd* |
|---|---|---|
| 1 | 37.50 | 31.82 |
| 2 | 30.00 | 26.458 |
| 3 | 11.33 | 8.083 |
| 4 | 50.00 | .000 |
| 6 | 10.33 | 8.083 |
| 7 | 31.00 | 24.759 |
| 8 | 23.50 | 14.849 |
| 9 | 4.67 | 3.512 |
| 13 | 12.00 | 8.000 |
| 14 | 6.00 | 4.359 |
| 15 | 25.00 | 23.805 |
| 16 | 40.00 | 28.284 |
| 17 | 83.33 | 37.859 |
| 18 | 14.50 | 13.279 |

*Table 17 Continued*

| Team | *m* | *sd* |
|---|---|---|
| 19 | 15.00 | 7.071 |
| 20 | 15.50 | 20.506 |
| 21 | 57.50 | 12.152 |
| 22 | 16.50 | 19.468 |
| 23 | 8.00 | 2.646 |
| 24 | 24.33 | 22.679 |
| 25 | 23.50 | 20.469 |
| 27 | 41.67 | 12.583 |
| 28 | 19.33 | 16.258 |
| 29 | 90.00 | 14.142 |
| Missing | 4 | |

Question 14 dealt with previous participation in agricultural mechanics CDEs. Frequencies and percentages were calculated for respondents' competition in previous agricultural mechanics CDEs.  Four choices were possible; 1 – 3 events, 4 – 8 events, 7 – 9 events, and 10 or more events.  The mean level of participation in previous agricultural mechanics CDEs was 1.44.  Students must qualify to participate in the State Agricultural Mechanics CDE by competing in an Area CDE, which counts as one CDE. Competing in that day's state Agricultural Mechanics CDE also counted as 1 event participation. More than half of the respondents had participated in 3 or fewer agricultural mechanics CDEs. A t-test was conducted ($p$ = .08, $t$ = 1.828) and the means of the groups were not significantly different; cooperators and non-cooperators participated in agricultural mechanics CDEs at similar rates. These data were summarized in Table 18.

*Table 18*

*Participation in agricultural mechanics CDEs (n =99)*

| Number of CDEs | *f* | Percent (%) |
|---|---|---|
| 1 – 3 | 55 | 55.6 |
| 4 - 6 | 13 | 13.1 |
| 7 – 9 | 6 | 6.1 |
| 10 – 12 | 3 | 3.0 |
| Missing | 22 | |

Question 15 related to student participation in the Texas FFA Tractor Technician CDE. 18 (18.2%) students had previously participated in this conceptually-related CDE; 62 (62.6%) indicated they had not. 19 students did not respond to this question. The mean of responses was 1.78.

Question 16 was designed to assess perceived classroom performance in agricultural mechanics instruction. Frequencies and percentages were calculated for respondents' typical grade in agricultural mechanics courses. Four choices were possible; A, B, C, and D. The mean expected grade in agricultural mechanics courses was 1.05. Almost ¾ of respondents expected to earn an A in agricultural mechanics courses; no respondents expected to earn average or below-average grades. A t-test was conducted ($p$ = .31, $t$ = -.1.04) and the means of the groups were not significantly different; there was no significant difference in the agricultural mechanics grades of both groups.

Question 17 asked participants to estimate their overall grade in all courses. Four choices were possible; A, B, C, and D. The mean anticipated grade was 1.48, midway between an A and a B. Over 80% of respondents estimated an overall average grade of B or higher. A t-test was conducted ($p$ = .59, $t$ = .54) and the means of the groups were not significantly different; there was no difference in the overall GPAs of the two groups.

The data for Questions 16 and 17, dealing with student expectations for grades are combined and summarized in Table 19.

*Table 19*

*Expected grade in agricultural mechanics courses and overall average grade (n = 99)*

| Grade | *f* Ag Mech courses | Percentage (%) Ag Mech courses | *f* Overall grade | Percentage (%) Overall grade |
|---|---|---|---|---|
| A | 74 | 74.4 | 43 | 43.4 |
| B | 4 | 4.0 | 37 | 37.3 |

*Table 19 Continued*

| Grade | *f* Ag Mech courses | Percentage (%) Ag Mech courses | *f* Overall grade | Percentage (%) Overall grade |
|---|---|---|---|---|
| C | 0 | 0 | 1 | 1.0 |
| D | 0 | 0 | 0 | 0 |
| Missing | 21 | | 18 | |

Questions 18, 19 and 20 dealt with student performance on the 2007 Mathematics TAKS assessments. The 2008 9th grade Mathematics TAKS assessment, 10th grade Mathematics TAKS assessment, and Exit level Mathematics TAKS assessment were administered the week following the State Agricultural Mechanics CDE. Timing of the administration greatly affected the results of these questions. Over half of the respondents in each category indicated mastery of the mathematics TAKS assessment. The 2007 statewide mean performance level for the 9th and 10th grade TAKS mathematics assessments was 77%, and the performance level for the TAKS exit mathematics objectives was 80%. These data for 2007 are reported in Table 20.

*Table 20*

*Mastery of grade-level TAKS mathematics assessment (n = 99)*

| Descriptor | *f* | Percentage (%) | Mean |
|---|---|---|---|
| Master 9th grade | 79 | 79.8 | 1.02 |

*Table 20 Continued*

| Descriptor | *f* | Percentage (%) | Mean |
|---|---|---|---|
| Not master 9th grade | 2 | 2 | |
| Master 10th grade | 68 | 68.7 | 1.16 |
| Not master 10th grade | 14 | 14.1 | |
| Master Exit level | 51 | 51.5 | 1.35 |
| Not master Exit level | 28 | 28.3 | |
| Missing | 20 | | |

Question 21 ascertained student grade in school. The mean of grade level was 3.33. More than 75% of the participants were sophomores or older. A t-test was conducted ($p = .09$, $t = -1.759$) and the means of grade levels of cooperators and non – cooperators were not significantly different. These data are summarized in Table 21.

*Table 21*

*Grade level of respondents (n = 99)*

| Grade | *f* | Percentage (%) |
|---|---|---|
| Freshman | 2 | 2.02 |
| Sophomore | 10 | 10.1 |
| Junior | 22 | 22.2 |

*Table 21 Continued*

| Grade | *f* | Percentage (%) |
|---|---|---|
| Senior | 44 | 44.4 |
| Missing | 21 | |

Question 22 ascertained the makeup of the respondents by gender; 5 (5%) of the questionnaires were completed by females; 94 were completed by males.

Question 23 asked the respondents to identify their ethnicity. Six responses were available; Native American, Asian American, African-American, Hispanic American, European American, and Other. Two-thirds of respondents were European American. These data are presented in Table 22.

*Table 22*

*Ethnicity of respondents (n = 99)*

| Descriptor | *f* | Percentage (%) |
|---|---|---|
| Native American | 1 | 1.0 |
| Asian American | 2 | 2.0 |
| African American | 1 | 1.0 |
| Hispanic American | 10 | 10.1 |
| European American | 66 | 66.7 |

*Table 22 Continued*

| Descriptor | *f* | Percentage (%) |
|---|---|---|
| Other | 1 | 1.0 |
| Missing | 18 | |

Question 24 dealt with respondents' participation in band, orchestra, or choir programs. Possible answers were Yes, Currently, Never, and No Longer. Respondents were equally divided between those who were or had previously enrolled in band, orchestra or choir programs and those who had never enrolled in band, orchestra or choir programs. Approximately half of the students were or had been in band, orchestra or choir programs; half of the students had never been in band, orchestra or choir. A t-test was conducted ($p$ = .54, $t$ = .63) and there was no significant difference in the means of cooperator and non-cooperator participation in band, choir, or orchestra. These data are presented in Table 23.

*Table 23*

*Participation in band, orchestra or choir programs (n = 99)*

| Descriptor | *f* | Percentage (%) |
|---|---|---|
| Never | 39 | 39.4 |
| No longer | 32 | 32.3 |

*Table 23 Continued*

| Descriptor | *f* | Percentage (%) |
|---|---|---|
| Yes, Currently | 7 | 7.1 |
| Missing | 21 | |

<u>Question 25</u> asked those respondents who had indicated that they currently or formerly participated in band, orchestra, or choir programs to identify the grade level of their participation. The mean response was 2.13. Three times as many respondents participated in band, orchestra or choir programs prior to high school enrollment. A t-test was conducted ($p$ = .38, $t$ = -.90) and there was no significant difference in the means of cooperators and non-cooperators in grade level of participation in band, choir, or orchestra. These data are presented in Table 24.

*Table 24*

*Grade level of band, orchestra, or choir participation (n = 38)*

| Descriptor | *f* | Percentage (%) |
|---|---|---|
| Elementary | 5 | 5.1 |
| Middle school | 23 | 23.2 |
| High school | 10 | 10.1 |

Nine composite variables utilizing survey data were developed to make inferential comparisons for this study. Those composite variables were; Total Number of Agricultural Science Courses, Total Number of Agricultural Mechanics Courses, Total Number of Mathematics Courses, Total Number of Basic Mathematics Courses, Total Number of Contextual Mathematics Courses, Total Number of Higher Mathematics Courses, Total Number of Science Courses, Total Number of Basic Science Courses and Total Number of Contextual Science Courses.

The variable Total Number of Agricultural Science Courses was derived by summing all agricultural science courses taken by all team members. Fifteen specific course options were available for selection, and one option was available for other Ag class. Total Number of Agricultural Mechanics Courses taken was derived by summing responses for Introduction to Agricultural Mechanics, Agricultural Structures, Welding, Ag Power, Ag Mech Lab, Ag Electronics, Home Maintenance, and Tractor Lab for all team members. Total Number of Mathematics Courses taken was derived by summing all mathematics courses taken by all team members. Total Number of Science Courses taken was derived by summing all science courses taken by all team members. The descriptive data for course enrollment patterns are presented in Table 25.

*Table 25*

*Course enrollment patterns by team (n = 99)*

| Team | Ag. Sci. | Ag. Mech. | Math | Cont. Math | Science | Cont. Science |
|---|---|---|---|---|---|---|
| 1 | 4.00 | 2.50 | 3.50 | 1.00 | 3.00 | 3.50 |
| 2 | 4.33 | 2.33 | 3.00 | | 3.00 | 3.00 |
| 3 | 3.00 | 1.75 | 2.00 | | 2.00 | 2.00 |
| 4 | 5.67 | 4.00 | 3.67 | | 2.33 | 3.67 |
| 5 | 5.50 | 2.75 | 3.60 | | 2.50 | 3.50 |
| 6 | 5.75 | 3.75 | 3.50 | | 1.75 | 3.50 |
| 7 | 3.67 | 1.67 | 4.33 | | 3.33 | 4.33 |
| 8 | 3.00 | 2.00 | 3.67 | | 2.33 | 3.67 |
| 9 | 3.67 | 2.33 | 3.00 | | 2.67 | 3.00 |
| 10 | 4.50 | 2.75 | 3.75 | 1.00 | 0.00 | 3.75 |
| 11 | 5.25 | 2.50 | 3.00 | | 1..25 | 3.00 |
| 12 | 4.67 | 2.67 | 2.33 | | 1.00 | 2.33 |
| 13 | 7.00 | 2.33 | 3.67 | | 3.33 | 3.67 |
| 14 | 5.67 | 2.33 | 4.33 | | 3.33 | 4.33 |
| 15 | 3.75 | 1.75 | 3.75 | | 3.25 | 3.75 |
| 16 | 3.00 | 1.50 | 4.00 | | 3.50 | 4.00 |
| 17 | 3.33 | 1.00 | 4.00 | | 4.00 | 4.00 |
| 18 | 4.75 | 3.00 | 3.50 | | 3.75 | 3.50 |

*Table 25 Continued*

| Team | Ag. Sci. | Ag. Mech. | Math | Cont. Math | Science | Cont. Science |
|---|---|---|---|---|---|---|
| 19 | 9.50 | 5.00 | 4.00 | | 1.50 | 4.00 |
| 20 | 6.25 | 3.00 | 2.75 | | 2.50 | 2.75 |
| 21 | 2.25 | 1.25 | 2.75 | | 2.25 | 2.75 |
| 22 | 5.25 | 2.25 | 4.25 | | 3.50 | 4.25 |
| 23 | 1.67 | .33 | 2.67 | | 2.00 | 2.67 |
| 24 | 3.00 | 1.50 | 4.75 | 1.00 | 2.75 | 4.75 |
| 25 | 8.50 | 5.50 | 4.00 | | 3.50 | 4.00 |
| 26 | 3.67 | 2.33 | 3.33 | 1.00 | 1.00 | 3.33 |
| 27 | 3.33 | 1.00 | 2.67 | | 2.67 | 2.67 |
| 28 | 3.33 | 1.00 | 4.33 | | 5.00 | 4.33 |
| 29 | 8.00 | 4.25 | 4.25 | 1.00 | 1.25 | 4.25 |

The mean Total Number of Agricultural Science Courses for cooperators was 4.62, and the mean for non-cooperators was 4.70. These means were tested ($t = -.12_{df=27}$ $p = .90$), and found not to be different.

The mean Total Number of Agricultural Mechanics Courses for cooperators was 2.56, and the mean for non-cooperators was 2.31. These means were tested ($t = .56_{df=27}$ $p = .58$), and found not to be different.

The mean Total Number of Mathematics Courses for cooperators was 3.30, and the mean for non-cooperators was 3.71. A t-test was conducted ($t = -1.66_{df=27}$ $p = .11$), and the means were found not to be different.

The mean Total Number of Basic Mathematics Courses for cooperators was 3.00, and the mean for non-cooperators was 3.00. A t-test for the Total Number of Basic Mathematics Courses could not be conducted because the standard deviations of both groups were 0.

The mean Total Number of Contextual Mathematics Courses for cooperators was 1.00, and the mean for non-cooperators was 1.00. A t-test for Total Number of Contextual Mathematics Courses could not be conducted because the standard deviations of both groups were 0.

The mean Total Number of Higher Mathematics Courses for cooperators was .46, and the mean for non-cooperators was .58. A t-test was conducted ($t = .74_{df=27}$ $p = .46$), and the means were found not to be different.

The mean Total Number of Science Courses for cooperators was 2.19, and the mean for non-cooperators was 2.86. A t-test was conducted ($t = 1.72_{df=27}$ $p = .10$), and the means were found not to be different.

The mean Total Number of Basic Science Courses for cooperators was 2.08, and the mean for non-cooperators was 2.49. A t-test was conducted ($t = 1.23_{df=27}$ $p = .23$), and the means were found not to be different.

The mean Total Number of Contextual Science Courses for cooperators was 3.30, and the mean for non-cooperators was 3.71. A t-test was conducted ($t = 1.66_{df=27}$ $p = .11$), and the means were found not to be different.

On all nine of these composite variables, we were unable to detect any difference between cooperators and non-cooperators with regard to course enrollment patterns.

Inter-relationships between Cooperator Status and Survey Variables

This section of the findings reports significant relationships between many of the variable in the study. Pearson's product moment correlations were conducted to detect relationships between cooperator status and variables derived from the questionnaire. Those correlations found to be statistically significant ($p < .05$) are reported below in the following order,

- items related to course enrollment;
- items related to cooperator status;
- items related to graphing calculator use;
- items related to the relationship between the CDE and classroom instruction;
- items related to academic grade;
- items related to CDE final placing;
- items related to CDE participation;
- items related to TAKS assessment, and
- items related to participation in performance fine arts.

Correlations between demographic variables and descriptive variables are included. This study has employed the Davis convention in all cases to report these correlations as being negligible, low, moderate, substantial, very high, and perfect. Miller (1994) posits that the Davis convention is applicable to research in agricultural education. These findings are listed as Objective 1B, 1C, 1D, etc.

Objective 1B – Interrelationships between Items Related to Course Enrollment

Question 1, number of agricultural science courses taken, was related to several items. A significant ($p$ =.00, $r$ = .83) very strong relationship was detected between total number of agricultural science courses taken and total number of agricultural mechanics courses taken. Students who had taken a greater number of agricultural science courses had probably taken a greater number of agricultural mechanics courses. A significant ($p$ =.02, $r$ = .23) low relationship was detected between total number of agricultural science courses taken and Question 4, total number of mathematics courses taken. Students who had taken a greater number of agricultural science courses had taken a greater number of mathematics courses. A significant ($p$ =.02, $r$ = .23) low relationship was detected between Question 1, total number of agricultural science courses taken and total number of contextual science courses taken. Students who had taken a greater number of agricultural science courses had taken a greater number of contextual science courses.

A significant ($p$ =.01, $r$ = -.26) low relationship was detected between total number of agricultural mechanics courses taken and Question 4, total number of mathematics courses taken.  Students who had taken a greater number of agricultural science courses were likely to have taken a greater number of mathematics courses.

A significant (*p* =.01, *r* = .26) low relationship was detected between Question 4 and Question 7, level of expertise with a graphing calculator. Students who were more expert users of graphing calculators reported completing more mathematics courses.

A significant (*p* =.00, *r* = .76) very strong relationship was detected between total number of higher mathematics courses taken and total number of contextual science courses.  Students who had taken a greater number of higher mathematics courses were very likely to have taken a greater number of contextual science courses.

Question 11, total number of science courses taken, was related to several variables.  A significant (*p* =.00, *r* = .29) low relationship was detected between total number of science courses taken and Question 4.  Students who had taken a greater number of science courses were likely to have taken more mathematics courses.

A significant (*p* =.00, *r* = .29) low relationship was detected between total number of science courses taken and total number of contextual science courses taken. Students who had taken a greater number of science courses were likely to have taken a greater number of contextual science courses.

A significant (*p* =.05, *r* = .20) low relationship was detected between total number of basic science courses taken and Question 4, total number of mathematics courses taken.  Students who had taken a greater number of basic science courses were likely to have taken a greater number of mathematics courses.

Objective 1C – Interrelationships between Items Related to Cooperator Status

Cooperation status was significantly related to several items. A significant (*p* =.01, *r* = .26) low correlation existed between cooperation status and Question 2, the relationship of the agricultural mechanics CDE to agriscience instruction (Davis, 1971). Cooperators felt that there was a closer relationship between the agricultural mechanics CDE and their agricultural science instruction.

A significant (*p* =.01, *r* = .26) negative low relationship was detected between cooperation status and Question 11, total number of science courses enrolled. Cooperators were slightly more likely to have taken more science courses.

A significant (p =.05, *r* = -.23) negative low relationship was detected between cooperation status and Question 14, frequency of participation in the agricultural mechanics CDE. Cooperators did not participate in a greater number of agricultural mechanics CDEs.

Objective 1D- Interrelationships between Items Related to Graphing Calculator Use

A significant (*p* =.01, *r* = -.27) negative low relationship was detected between Question 5, use of a graphing calculator at school, and Question 4, total number of mathematics courses completed. Students who used graphing calculators at school reported completing a greater number of mathematics courses.

A significant (*p* =.01, *r* = .26) low relationship was detected between Question 5, and Question 6, frequency of graphing calculator use. Students who use graphing calculators at school use them more frequently.

A significant ($p$ =.02, $r$ = -.23) negative low relationship was detected with Question 7, level of expertise with a graphing calculator. Students who used graphing calculators at school reported having higher levels of expertise with their use.

A significant ($p$ =.01, $r$ = -.27) negative low relationship was detected between Question 5, and the composite variable, total number of contextual science courses completed. Students who used graphing calculators at school reported completing more contextual science courses.

Question 6, frequency of graphing calculator use, was correlated to several items. A significant ($p$ =.04, $r$ = .20) low relationship was detected between Question 6 and Question 8, ownership of a graphing calculator. Students who own graphing calculators use graphing calculators more frequently. A significant negative low relationship ($p$ =.04, $r$ = -.23) was detected between Question 6 and Question 20, passing the exit TAKS mathematics assessment. Students who used graphing calculators frequently were less likely to have passed the exit TAKS mathematics assessment. A significant ($p$ =.00, $r$ = .36) moderate relationship was detected with Question 21, grade level. Students who used graphing calculators frequently were more likely to be younger students.

Question 7, level of expertise with a graphing calculator, was correlated to several items. A significant ($p$ =.00, $r$ = -.29) negative low relationship was detected between Question 7 and Question 8, ownership of a graphing calculator. Students who were more expert users of graphing calculators were more likely to own graphing calculators. A significant ($p$ =.00, $r$ = -.34) negative moderate relationship was detected with Question 10, mathematics grade. More expert users of graphing calculators reported making higher grades in mathematics. Level of expertise was scored from low to high, and mathematics grade was scored from high to low. A significant ($p$ = .05, $r$ = -.23) negative low relationship was detected with Question 13, predicted individual placing in the agricultural mechanics CDE. Students who were more expert users of graphing calculators expected to have lower individual ranking (thus placing higher) in the agricultural mechanics CDE. A significant ($p$ =.01, $r$ = -.30) negative moderate relationship was detected between Question 7 and Question 17, overall GPA (A = 1; D=4). Students who were more expert users of graphing calculators were expected to earn higher grades overall. A significant ($p$ =.01, $r$ = .25) low relationship was detected between Question 7 and the total number of higher mathematics courses completed. Students who were more expert users of graphing calculators reported completing a larger number of higher mathematics courses. A significant ($p$ =.01, $r$ = .26) low relationship was detected between Question 7 and the total number of contextual science courses completed. Students who were more expert users of graphing calculators reported completing a greater number of contextual science courses.

Question 8, ownership of a graphing calculator (Yes = 1, No =2) was correlated to several items. A significant ($p$ =.04, $r$ = .24) low relationship was detected between owning a graphing calculator and Question 16, agricultural mechanics grade. Students who owned graphing calculators were more likely to have higher grades in agricultural mechanics. A significant ($p$ =.00, $r$ = .33) moderate relationship was detected between Question 8 and Question 20, passing the exit mathematics TAKS assessment. Students who owned graphing calculators were less likely to have passed the exit mathematics

TAKS assessment. A significant ($p$ =.00, $r$ = -.40) negative and moderate relationship was detected between Question 8 and Question 4, total number of mathematics courses completed. Students who owned graphing calculators were more likely to have taken more mathematics courses. A significant ($p$ =.01, $r$ = -.40) negative and low relationship was detected between Question 8, and the total number of higher mathematics courses completed. Students who owned graphing calculators reported taking greater numbers of higher mathematics courses. A significant ($p$ =.00, $r$ = .38) negative moderate relationship was detected between Question 8, owning a graphing calculator and total number of contextual science courses completed. Students who owned graphing calculators reported taking more contextual science courses.

Objective 1E – Interrelationships between Items Related to CDE Participation and Classroom Instruction

Question 2, the relationship of the agricultural mechanics CDE to classroom instruction, was related to several items. A significant ($p$ =.02, $r$ = -.23) negative low relationship was detected between with Question 1, the total number of agricultural science courses taken. Students taking more AFNR classes were more likely to view the agricultural mechanics CDE as closely related to their classroom instruction in agricultural science.

A significant ($p$ = .03, $r$ = -.22) negative low correlation was detected between Question 2 and Question 7, the level of expertise with a graphing calculator. Those who reported the agricultural mechanics CDE as being more closely related to their classroom instruction reported higher levels of expertise in using a graphing calculator.

Objective 1F – Interrelationships between Items Related to Academic Grade

Question 10, self-reported grade in mathematics, was correlated to several items. A significant ($p$ =.02, $r$ = .27) low relationship was detected between mathematics grade and Question 13, predicted individual placing in the agricultural mechanics CDE. Students who had higher mathematics grades felt they were more likely to place higher as an individual in the agricultural mechanics CDE. A significant ($p$ =.00, $r$ = .38) and moderate relationship was detected between mathematics grade and Question 17, overall average GPA. Students who had higher mathematics grades reported having higher overall GPAs. A significant ($p$ =.02, $r$ = -.24) negative low relationship was detected between Question 10, mathematics grade (A=1, D=4) and total number of higher mathematics courses taken. Students who reported higher mathematics grades took a greater number of higher mathematics courses. A significant ($p$ =.01, $r$ = -.24) negative low relationship was detected between Question 10 and total number of contextual science courses taken. Students who reported higher mathematics grades took a greater number of contextual science courses.

Question 16, self-reported grade in agricultural mechanics, was correlated to several items. A significant ($p$ =.04, $r$ = -.24) low relationship was detected between agricultural mechanics grade and Question 8, ownership of a graphing calculator. Students who had higher agricultural mechanics grades were slightly more likely to own a graphing calculator. Agricultural mechanics grades were inversely scored. A significant (*p* =.05, *r* = -.22) negative low relationship was detected between Question 16 and total number of agricultural mechanics courses taken. Students who had higher agricultural mechanics grades were more likely to have taken fewer agricultural mechanics courses. A significant (*p* =.04, *r* = -.23) negative low relationship was detected between agricultural mechanics grade and Question 4, total number of mathematics courses taken. Students who had higher agricultural mechanics grades were more likely to have taken more mathematics courses. A significant (*p* =.04, *r* = -.23) negative low relationship was detected between Question 16, agricultural mechanics grade and total number of contextual science courses taken. Students who had higher agricultural mechanics grades were more likely to have taken contextual science courses.

Question 17, self-reported overall average GPA, was correlated to several items. A significant (*p* =.05, *r* = -.23) negative low relationship was detected between overall GPA and Question 24, participation in band, orchestra or choir. Students who had higher overall GPAs were less likely to have participated in band, orchestra or choir. A significant (*p* =.01, *r* = -.30) negative low relationship was detected between overall GPA and Question 4, total number of mathematics courses. Students who had higher overall GPAs had taken fewer mathematics courses. A significant (*p* =.01, *r* = -.31) negative moderate relationship was detected between overall GPA and total number of higher mathematics courses. Students who had higher overall GPAs had taken fewer higher mathematics courses. A significant (*p* =.01, *r* = -.30) negative low relationship was detected between Question 17, overall GPA and total number of contextual science courses. Students who had higher overall GPAs had taken fewer contextual science courses.

Question 1G – Interrelationships between Items Related to CDE Final Placing

Question 12, projected team placing, was correlated to several items. A significant ($p$ =.00, $r$ = .66) substantial relationship was detected between projected team placing and Question 13, projected individual placing. Students who felt their team would place high also felt that they would have higher individual placings. This question focuses on the assumption that the members of each team strive to place first, or be on the winning team. Final team ranking is inversely related to total team numerical score.

A significant ($p$ =.01, $r$ = .30) low relationship was detected between projected team placing and Question 15, participation in the tractor technician CDE. Students who felt their team would place well (rank low) were more likely to have participated in the tractor technician CDE.

A significant ($p$ =.05, $r$ = -.23) negative and low relationship was detected between Question 13, projected individual placing and Question 7, level of expertise with a graphing calculator. Students who felt they would place well (Rank 1-120) as individuals were competent users of graphing calculators (Novice 1, Expert 4).

A significant ($p$ =.02, $r$ = .27) low relationship was detected between projected individual placing (rank 1-120) and Question 10, mathematics grades (A=1, D=4).

Students who felt they would place higher as individuals tended to have higher grades in mathematics.

A significant (*p* =.02, *r* = .28) low relationship was detected between projected individual placing and Question 15, participation in the tractor technician CDE (Yes = 1, No = 2). Students who felt they would place well as individuals; have a lower numerical ranking, participated in the tractor technician CDE.

A significant (*p* =.01, *r* = .29) low relationship was detected between projected individual placing and Question 20, passing the mathematics TAKS assessment. Students who felt they would place well (rank numerically lower) as individuals participating in the CDE tended to have passed the mathematics TAKS assessment.

Objective 1H – Interrelationships between Items Related to CDE Participation

Question 14, participation in agricultural mechanics CDEs, was correlated to several items. A significant (*p* =.01, *r* = .28) low relationship was detected between Question 14, number of agricultural mechanics CDEs and total number of agricultural mechanics courses taken. Students who had participated in a greater number of agricultural mechanics CDEs tended to have taken a greater number of agricultural mechanics courses. A significant (*p* =.03, *r* = .25) low relationship was detected between number of agricultural mechanics CDEs and Question 4, total number of mathematics courses taken. Students who had participated in a greater number of agricultural mechanics CDEs tended to have taken a greater number of mathematics courses. A significant (*p* =.03, *r* = .25) low relationship was detected between Question

14, number of agricultural mechanics CDEs and total number of contextual science courses taken. Students who had participated in a greater number of agricultural mechanics CDEs tended to have taken a greater number of contextual science courses.

Question 15, participation in the tractor technician CDE, was correlated to several items. A significant ($p$ =.01, $r$ = .30) low relationship was detected between participation in the tractor technician CDE and Question 12, projected team placing. Students who had participated in the tractor technician CDE were more likely to think their team would place higher in the agricultural mechanics CDE. A significant ($p$ =.02, $r$ = -.26) negative low relationship was detected between Question 15, participation in the tractor technician CDE and total number of agricultural mechanics courses taken. Students who had participated in the tractor technician CDE were more likely to have taken fewer agricultural mechanics courses. A significant ($p$ =.04, $r$ = -.26) negative low relationship was detected between Question 15, participation in the tractor technician CDE and total number of contextual science courses taken. Students who had participated in the tractor technician CDE were less likely to have taken contextual science courses.

<u>Objective 1I – Interrelationships between Items Related to TAKS Assessments</u>

Question 19, taking the 10th grade TAKS mathematics assessment, was correlated to several items. A significant ($p$ =.00, $r$ = -.64) negative substantial relationship was detected between Question 19 and Question 4, total number of basic mathematics courses taken. Students who had taken the 10th grade mathematics TAKS assessment had taken fewer mathematics courses.

Objective 1J – Interrelationships between Items Related to Participation in Performance Fine Arts

A significant (*p* =.05, *r* = -.23) negative low relationship was detected between Question 24, membership in band, orchestra, or choir programs (Never = 1, Now =3) and Question 17, overall Average GPA (A=1, D=4). Students who were current members of the band, orchestra, or choir programs reported higher overall GPAs.

Question 25, participation in band, orchestra or choir, was correlated to several items. A significant (*p* =.05, *r* = -.34) negative moderate relationship was detected between participation level and Question 20, passing the exit mathematics TAKS assessment. As level of participation in band, orchestra, or choir programs increased from elementary to high school, students were less likely to report passing the exit mathematics TAKS assessment.

RESEARCH OBJECTIVE 2

Research Objective 2 explored the differences in Written Examination, Team Individual Skill scores, and Team Activity scores between teams exposed to mathematics enrichment activities and those that were not.

For the 2008 State Agricultural Mechanics CDE, the mean score on the written examination for teams cooperating in the enrichment activity was 69.53; mean score for teams not cooperating was 57.21. Cooperator teams scored an average of 12.32 points higher than non-cooperator teams. Individual members of cooperating teams, based on a 3-member team, scored 4.1 points higher than non-cooperators on the written examination.

An analysis of effect size (ES) of the written examination scores between cooperators and non-cooperators was a score (*d*) of 1.61, which is a large effect size. An analysis of effect size (ES) of the team activity scores between cooperators and non-cooperators yielded a score (*d*) of .001, which is a small effect size. There were 29 degrees of freedom in these analyses. The data for standard deviations of the 2008 written examination and team activity scores are displayed in Table 26.

*Table 26*

*Standard deviations of written examination and team activity scores*

| Standard deviations | Cooperators | Non-cooperators |
|---|---|---|
| 2008 Written Exam | 7.98 | 7.42 |
| 2008 Team Activity | 7.99 | 9.37 |

Independent sample T-tests were conducted on 12 different survey items, comparing those items by cooperator status. The level of significance was set at .05. The results of those tests are displayed in Table 27.

*Table 27*

*Survey items contrasted with cooperator status (n = 2, df 1, 27))*

| Descriptor | Cooperator mean | Non-cooperator mean | *t* | *p* |
|---|---|---|---|---|
| Q 5 GC at school | 1.08 | 1.03 | 1.30 | .21 |
| Q 6 Frequent GC Use | 1.99 | 2.01 | -.05 | .96 |
| Q 7 GC Expertise | 2.62 | 2.55 | .40 | .695 |
| Q 8 Own a GC | 1.51 | 1.51 | -.03 | .98 |
| Q 10 Math Grade | 1.46 | 1.52 | -.54 | .59 |
| Q 14 Ag Mech CDEs | 1.79 | 1.32 | 1.83 | .08 |
| Q 16 Ag Mech Grade | 1.02 | 1.07 | -1.04 | .31 |
| Q 17 Overall GPA | 1.53 | 1.46 | .54 | .59 |
| Q 21 Grade Level | 3.16 | 3.53 | -1.76 | .09 |
| Q 24 Fine Arts part. | 2.39 | 2.28 | .63 | .54 |
| Q 25 Fine Arts year | 1.94 | 2.16 | -.90 | .38 |

T-tests were conducted on several different survey items. The results were not significant at the .05 level established a priori.

The difference between the means was not significant in the use of graphing calculators at school by cooperation status (Q5) ($t = 1.30_{\text{df}=27,}$ $p = .21$).

The difference between the means was not significant between frequency of graphing calculators use (Q6) by cooperation status ($t$ = -.05 $_{df=27}$, $p$ = .96)

The difference between the means was not significant between level of expertise with graphing calculators (Q7) by cooperation status ($t$ = .40 $_{df=27}$ $p$ = .70).

The difference between the means was not significant between ownership of a graphing calculator (Q8) by cooperation status ($t$ = -.31 $_{df=27}$ $p$ = .98).

The difference between the means was not significant between self-reported mathematics grade (Q10) by cooperation status ($t$ = -.54 $_{df=27}$ $p$ = .59).

The difference between the means was not significant between frequency of competition in agricultural mechanics CDEs (Q14) by cooperation status ($t$ = 1.82 $_{df=26,}$ $p$ = .08).

The difference between the means was not significant between self-reported agricultural mechanics grade (Q16) by cooperation status ($t$ = -1.04 $_{df=25}$, $p$ = .31)

The difference between the means was not significant between self-reported overall average GPA (Q17) by cooperation status ($t$ = .54 $_{df=26}$, $p$ = .59).

The difference between the means was not significant between current grade level (Q21) by cooperation status ($t$ = -1.76 $_{df=26}$, p = .09).

The difference between the means was not significant between participation in performance based fine arts programs (Q24) by cooperation status ($t$ = .63 $_{df=26}$ ,$p$ = .54).

The difference between the means was not significant between grade level of participation in performance based fine arts programs (Q25) by cooperation status ($t$ = -.90 $_{df=20}$, $p$ = .38).

The lack of significant findings resulting from these t-tests confirms that participating students did not differ from non-participants. Cooperators and non-cooperators were not different from each other on these variables.

To control experiment-wise error, a one-way analysis of variance (ANOVA) was conducted to compare cooperation status with these 11 selected survey responses. This was done for purposes of clarity and to control experiment-wise error.

These 11 variables were included in a one-way analysis of variance (ANOVA). The 11 variables were use of graphing calculators at school (Q5), frequency of graphing calculators use (Q6), level of expertise with graphing calculators (Q7), graphing calculator ownership (Q8), self-reported mathematics grade (Q10), frequency of competition in agricultural mechanics CDEs (Q14), self-reported agricultural mechanics grade (Q16), self-reported overall average GPA (Q17), current grade level (Q21), participation in band, orchestra, or choir (Q24), and grade level of participation in band, orchestra, or choir (Q25).

The findings of the ANOVA conduced on this subset of variables were that no variable was significantly different between cooperators and non-cooperators. For (Q5) the mean score for use of graphing calculators at school for cooperators was 1.08; the mean for non-cooperators was 1.03. Both groups used graphing calculators at school. For (Q6) frequency of graphing calculators use, the mean score for cooperators was 1.99 and 2.01 for non-cooperators. Both groups used graphing calculators at school on a weekly basis. For (Q7) the mean level of expertise with graphing calculators for cooperators was 2.62; and 2.55 for non-cooperators. Both groups scored between the intermediate and competent levels in using graphing calculators. For (Q8) graphing calculator ownership, the mean score for cooperators and non-cooperators was equal at 1.51. Both groups are equally likely to own graphing calculators. For (Q10) self-reported mathematics the mean score for cooperators was 1.46 and for non-cooperators 1.52. Both groups reported that they make a mid-range B grade in mathematics. For (Q14) frequency of competition in agricultural mechanics CDEs, the mean score for cooperators was 1.79 and 1.32 for non-cooperators. Both groups report participation in six or fewer agricultural mechanics CDEs. For (Q16) agricultural mechanics grade the mean score for cooperators was 1.02 and for non-cooperators was 1.07. Both groups report that they generally make an A in agricultural mechanics classes. For (Q17) overall average GPA the mean score for cooperators was 1.53 and for non-cooperators was 1.46. Both groups report that they have a mid-range B overall GPA. For (Q21) current grade level the mean score for cooperators was 3.16 and the mean for non-cooperators was 3.53. Both groups report that the teams are mostly composed of high school juniors. For (24) fine arts participation, the means score were 2.39 for cooperators and 2.28 for non-cooperators. Students were not different in their participation in participation in band, orchestra, or choir. For (Q25) the level of participation in band, orchestra, or choir (Elementary, Middle School, High School), the means score were 1.94 for cooperators and 2.16 for non-cooperators. Participants were not different in their level of participation in band, orchestra, or choir. These findings are summarized in Table 28.

*Table 28*

*Analysis of variance cooperator status by selected variables*

| Question | DF | MS | F | P |
|---|---|---|---|---|
| Q 5 GC at School | 1 | .02 | 1.69 | .21 |
| Q 6 Frequent GC Use | 1 | .002 | .003 | .96 |
| Q 7 GC Expertise | 1 | .030 | .16 | .66 |
| Q 8 Own a GC | 1 | .000 | .001 | .98 |
| Q 10 Math Grade | 1 | .031 | .29 | .59 |
| Q 14 Ag Mech CDEs | 1 | 1.54 | 3.34 | .08 |
| Q 16 Ag Mech Grade | 1 | .01 | 1.08 | .31 |
| Q 17 Overall GPA | 1 | .03 | .30 | .59 |
| Q 21 Grade Level | 1 | 1.10 | 3.09 | .09 |
| Q 24 Fine Arts participation | 1 | .09 | .40 | .53 |
| Q 25 Fine Arts grade level | 1 | .25 | .81 | .38 |
| Model | 6 | 119.39 | 2.79 | .04 |

Following this test, Cooperation Status was added as a variable along with several others. Results of this ANOVA indicate that the model was significant (p = .037), and cooperator status was significant (p = .001). None of the survey questions were found to have any power to explain differences in the results. The treatment, cooperating in the enrichment activities, had the only significant effect on explaining differences in average exam score. These data are displayed in Table 29.

*Table 29*

*Analysis of variance average examination score by selected variables*

| Question | DF | MS | F | P |
|---|---|---|---|---|
| Cooperation | 1 | 1090.42 | 15.26 | .001 |
| Q 6 Frequency | 1 | 21.98 | .31 | .59 |
| Q 7 GC Expertise | 1 | .341 | .005 | .95 |
| Q 8 Own a GC | 1 | 1.39 | .02 | .89 |
| Q 10 Math grade | 1 | 5.12 | .07 | .79 |
| Q 14 AgMc CDE | 1 | 26.33 | .37 | .55 |
| Model | 6 | 119.39 | 2.79 | .037 |

A series of t-tests were conducted between cooperators and non-cooperators for the outcome variables Average Exam Score, Team Individual Skill, Team Activity, and Total CDE Score. Level of significance for the T-tests was set a priori at .05. Within 27 degrees of freedom, significant results were obtained for two of these outcome variables.

When Average Exam Score was tested, the mean score for cooperators was 69.53; the mean of non-cooperators was 57.16, on an individual team member basis. The t-test statistic for Average Exam Score was significant (t = 4.30, $p = .00$). The difference in these means was 12.37. The effect size ($d = 1.61$) was large. The average written examination score for cooperators was in excess of 12 points higher than that of non-cooperators. The difference between written examination scores of cooperators and non-cooperators is large.

Although the mean for Total Individual Skill Score for cooperators was 44.52 and the mean for non-cooperators was 37.55, with a difference in means of 6.97, this result was not statistically significant ($p =.054$). The average individual skill score for cooperators was almost 7 points higher than that of non-cooperators. However, these results fell beyond the pre-determined level of significance of .05.

The mean Team Activity Score for cooperators was 26.08, and the mean for non-cooperators was 28.00. The t-test statistic for Team Activity Score was .75 with a significance of .53. While the difference in these means was 1.92, this difference was not statistically significant.

The mean Total CDE Score for cooperators was 140.13; the mean for non-cooperators was 122.71. The Total CDE score ($t = 2.44$, $p = .02$) had a difference in means of 17.42, and a large ($d = .91$) effect size. The average total CDE score for cooperators was almost 18 points higher than that of non-cooperators. The difference between total CDE scores of cooperators and non-cooperators is large.

The difference in Written Examination score between these two groups by Team, three members per team, would be 37.11. The difference in Total CDE Score between these two groups by Team was 52.26. The Written Exam score accounted for 71% of the variability in Total CDE score by Team. There is no statistically significant difference in Team Activity score due to cooperator status. Written Examination score and Team Activity score are not highly correlated. Mean Written Examination score is highly correlated to cooperator status.

## RESEARCH OBJECTIVE 3

Research Objective 3 sought to explore the relationship between the outcome variables Statewide TAKS mathematics and science scores, School TAKS mathematics and science scores, Team TAKS mathematics and science scores, and Team Composite State Agricultural Mechanics CDE scores, and perceived level of expertise with a graphing calculator, frequency of participation in CDEs between teams exposed to contextual mathematics enrichment activities and those that were not. The results of these tests are presented in the following order. Statewide TAKS score means for mathematics and science were analyzed and compared to the School TAKS Score means for mathematics and science. Effect sizes of selected variables are presented and followed by a description of the correlations among the outcome variables.

Statewide Exit level TAKS assessment scores were obtained for the study. The exit-level TAKS assessments in mathematics and science are given annually in late April or early May (Texas Education Agency, 2008a). The statewide mean scores for the 2007 and 2008 exit-level TAKS in mathematics and science are presented in Table 30.

*Table 30*

*Statewide exit level TAKS scores*

| Assessment | 2007 | 2008 |
|---|---|---|
| Mathematics | 2229 | 2246 |
| Science | 2196 | 2213 |

To test the differences between cooperators and non-cooperators, two outcome variables utilizing school exit TAKS performance data were developed. These variables were School TAKS Mathematics Score and School TAKS Science Score. The method for determining the School TAKS Mathematics and School TAKS Science score for each school is described in Chapter III. Post hoc tests were not performed on the School TAKS Exit Mathematics and Science scores because there were fewer than three groups involved in the study.

The 2008 mean School TAKS Mathematics score for cooperators was 2247. The 2008 mean School TAKS Mathematics score for non-cooperators was 2269 (Texas Education Agency, 2008b). The difference in these means was 22. Levene’s test of homogeneity of variances (.02) was not significant (.89). Since the test for homogeneity of variances was not significant, an independent samples t-test was conducted. The independent samples t-test (t = -.84) was not significant (p = .41).

The 2008 mean School TAKS Science score for cooperators was 2213.23. The mean School TAKS Science score for non-cooperators was 2226.56 (Texas Education Agency, 2008b). The difference in these means was 13.33. Levene's test of homogeneity of variances (.04) was not significant (.85). Since the test for homogeneity of variances was not significant, an independent samples t-test was conducted. An independent samples t – test (t = -.83) was not significant (.42).

Analyses of variance were conducted for School TAKS Mathematics score and School TAKS Science score. The schools represented by the cooperators and non-cooperators were not significantly different. These data are displayed in Table 31.

*Table 31*

*Analysis of variance of school TAKS mathematics and science scores*

| Question | DF | MS | F | P |
|---|---|---|---|---|
| Mathematics | 1 | 3369.04 | .82 | .37 |
| Science | 1 | 1274.79 | .68 | .42 |

An analysis of the descriptive data revealed differences in the means of student scores. Cooperators were from schools with lower TAKS mathematics scores than non-cooperators. The School TAKS Mathematics and Science scores for cooperators were very close to state mean exit scores for mathematics and science. The data are presented in Table 32.

*Table 32*

*Means of TAKS assessment scores*

| Enrichment Status | 2007 School Math | 2008 School Math | 2007 School Science | 2008 School Science | 2008 Team Math | 2008 Team Science |
|---|---|---|---|---|---|---|
| Cooperator | 2229.31 | 2247 | 2215.23 | 2213.23 | 2336.78 | 2289.12 |
| Non-cooperator | 2267.56 | 2269 | 2218.44 | 2226.56 | 2331.77 | 2329.79 |
| State TAKS Mean | 2229 | 2246 | 2196 | 2213 | | |
| State CTE Mean | 2022 | 2235 | 2188 | 2205 | | |

To further test the differences between cooperators and non-cooperators, two outcome variables utilizing team TAKS exit mathematics and science scores were developed. These variables were Team TAKS Mathematics Score, and Team TAKS Science Score. The method for calculating the Team TAKS Mathematics and Team TAKS Science scores is described in Chapter III.

The mean Team TAKS Mathematics score for cooperators was 2336.78; the mean for non-cooperators was 2331.77. The t-test (.08) for Team TAKS Mathematics Score was not significant (.94) which indicates that the difference between the groups is not statistically significant at the a priori level ($p = .05$). However, the difference in these means was 5.01.

The mean Team TAKS Science Score for cooperators was 2289.18; the mean score for non-cooperators was 2329.79. The t-test (-.84) for Team TAKS Science Score was not significant (41), which indicates that the difference between the groups is not statistically significant at the a priori level ($p = .05$). The difference in these means was 40.67. These data are presented in Table 32.

Analyses of variance were conducted for Team TAKS Mathematics score and Team TAKS Science score. The teams represented by the cooperators and non-cooperators were not significantly different. These data are displayed in Table 33.

*Table 33*

*Analysis of variance of team TAKS mathematics and science scores*

| Question | DF | MS | F | P |
|---|---|---|---|---|
| Mathematics | 1 | 129.36 | .01 | .94 |
| Science | 1 | 7834.84 | .71 | .41 |

Independent sample t-tests and Levene's Tests for Equality of Variances conducted to compare these outcome variables with cooperation status were not significant for either of these outcome variables when contrasted with cooperation status. There were 13 teams that were classified as cooperators, and 16 teams were non-cooperators. Level of significance for the t-tests was set a priori at .05. Within 27 degrees of freedom, significant results were obtained for only two of the outcome variables, Average Exam Score and Team Total CDE Score.

<u>Correlations and Effect Sizes between Outcome Variables</u>

Effect sizes for t-tests which identified significant results were also reviewed. Effect size is a descriptive measure of the differences detected in these t-tests. Effect size (ES) in this survey is the difference between two means divided by the pooled standard deviation of the data.

A series of Pearson's Product Moment Correlations were performed on selected survey variables and performance variables. Several significant correlations were identified. The mean of Estimates of Team's Final Placing (Question 12) had a negative and moderate ($r = -.43$) correlation ($p = .02$) with the Mean Total CDE Score. As student predicted that their Team Rank would be numerically low (nearing $1^{st}$ place) their Total Score went up. Students were statistically moderately accurate in their predictions.

The mean of Estimates of Individual Placing (Question 13) was negatively moderately related ($r = -.46$, $p = .04$) to compared with the Mean Total CDE Score. As student predicted that their Individual Rank would be numerically low (nearing 1st place) their Total Score went up. Students were statistically moderately accurate in their predictions.

The mean of the Total Number of Agricultural Science Courses was moderately related (r = .412, p = .03) to Mean Individual Activity Score (r = .39, p = .04) to the Total CDE Score. The mean of the Total Number of Higher Mathematics Courses Taken was moderately negatively related (r = -.38, p = .04) to Mean School Science TAKS Score.

The mean 2008 Team CDE Rank for cooperators was 13.69. The mean 2008 Team CDE Rank for non-cooperators was 15.33. Leven's test of homogeneity of variances (.00) was not significant (.99). An analysis of variance (ANOVA) between cooperators and non-cooperators found that Team CDE Rank was significantly different ($p$ = .01, $F = 7.76_{\text{df 1}}$) with a large ($d$= 1.00) effect size. Cooperation status had a large effect on 2008 Team CDE Rank.

The mean 2008 Team Total CDE Score for cooperators was 420.38. The mean 2008 Team Total CDE Score for non-cooperators was 368.13. Levene's test of homogeneity of variances (.29) was not significant (.60). An analysis of variance (ANOVA) between cooperators and non-cooperators found that Team Total Numeric Score was significantly different ($p$ = .02, $F = 5.93_{\text{df1}}$) with a large effect size ($d$ = 0.88). Cooperation status had a large effect on 2008 Team Total CDE Score. These data are displayed in Table 34.

*Table 34*

*Analysis of variance among TAKS Assessment and CDE scores (n = 2, f 1, 27)*

| Variable | DF | MS | F | P |
|---|---|---|---|---|
| 2008 Team Total CDE score | 1 | 19588.35 | 5.93 | .02 |
| 2008 Team TAKS Math score | 1 | 129.36 | .01 | .94 |
| 2008 Team TAKS Science score | 1 | 7834.84 | .71 | .41 |

The mean 2008 Team TAKS Mathematics score for cooperators was 2336.78. The mean 2008 Team TAKS Mathematics score for non-cooperators was 2331.77. The difference in these means is 5.01. An analysis of variance (ANOVA) between cooperators and non-cooperators found that Team TAKS Mathematics score was not significantly different ($p$ =.94, $F$ = .01) between groups.

The mean 2008 Team TAKS Science score for cooperators was 2289.12. The mean 2008 Team TAKS Science score for non-cooperators was 2329.79. The difference in these means is 40.67. An analysis of variance (ANOVA) between cooperators and non-cooperators found that Team TAKS Science score was not significantly different ($p$ =.41, $F$ = .71) between groups.

Cooperation status had no effect on the combined TAKS exit mathematics scores or science of the team members. Cooperators scored an average of 4.99 points higher than non-cooperators on the 2008 Mathematics TAKS Assessment. Cooperators scored an average of 40.68 points lower than non-cooperators on the on the 2008 Science TAKS Assessment.

There was no correlation between the mean Team Total CDE Score and perceived level of expertise with a graphing calculator at the .05 level. A univariate analysis of variance between the Team Total CDE Score and cooperation status was conducted ($f$ = .01, $p$ = .95), which was not significant at the a priori .05 level.

A univariate analysis of variance between the perceived level of expertise with a graphing calculator (Q7) and cooperation status was not significant ($f$ = .01, $p$ = .95).

A univariate analysis of variance between the frequency of participation in agricultural mechanics CDEs (Q14) and cooperation status was not significant ($f$ = .37, $p$ = .55) at the a priori .05 level. Results of these univariate analyses of variance are recorded in Table 35.

*Table 35*

*Univariate analysis of variance among level of expertise and frequency of participation*

| Question | DF | MS | F | P |
|---|---|---|---|---|
| Q 7 Expertise | 1 | .341 | .01 | .95 |
| Q 14 AgMc CDE | 1 | 26.33 | .37 | .55 |

## RESEARCH OBJECTIVE 4

Research Objective 4 explored the interrelationships between Team TAKS Exit Mathematics scores, Team Total CDE Score, and participation in fine arts courses between students exposed to contextual mathematics enrichment activities and those that were not.

Pearson's product moment correlations for survey question 24, participation in a school band, orchestra or choir, yielded no significant correlations with performance on exit-level mathematics or science TAKS assessments at the .05 level.

A significant ($p = .05$, $r = -.23$) negative low relationship was detected between overall GPA and Question 24, participation in band, orchestra or choir. Students who had higher overall GPAs were slightly more likely to have participated in band, orchestra or choir.

Pearson's product moment correlations for survey question 25, grade level of participation in school band, orchestra or choir, yielded no significant correlations with performance on exit-level mathematics or science TAKS assessments at the .05 level.

A significant ($p = .05$, $r = -.34$) negative moderate relationship was detected between participation in fine arts grade level and Question 20, passing the exit mathematics TAKS assessment. Students who reported being members of band, orchestra or choir programs at the lower grades were less likely to have passed the exit mathematics TAKS assessment.

A oneway analysis of variance between participation in fine arts courses (Q24) and cooperation status was conducted. The analysis yielded a result that was not significant (p = .54).

A oneway analysis of variance between the grade level of participation in fine arts courses (Q25) and cooperation status was conducted. The analysis yielded a result of .38, which was not significant. The mean for cooperators was 1.94; the mean for non-cooperators was 2.16. The t-test (*t* = .40) was not significant at the .05 level. Results of the oneway analyses of variance are recorded in Table 36.

*Table 36*

*Analysis of variance between cooperation status and participation in fine arts courses*

| Question | DF | MS | F | p |
|---|---|---|---|---|
| Q24 Participation | 1 | .09 | .395 | .54 |
| Q 25 Grade level | 1 | .25 | .87 | .38 |

SUMMARY OF FINDINGS

Thirty schools with Agricultural Mechanics Career Development Event teams were asked to participate in this study. Seventeen of those 30 teams participated in a mathematics enrichment activity. This participation provided a treatment group of those who cooperated in the enrichment activity and a control group of those who chose not to cooperate. Twenty-nine schools and 109 students competed in the 2008 Agricultural Mechanics CDE, including 13 teams who participated in the enrichment activity sessions.

Three distinct data sources were used in this study; a demographic and informational survey of participants in the 2008 State Agricultural Mechanics CDE, the results of that CDE, and TAKS assessment scores.

Student responses to this 25 item questionnaire comprised the first data source. Data from the 99 usable instruments were analyzed using descriptive and correlational techniques.

The second data source consisted of team performance data on the 2008 State Agricultural Mechanics CDE. Three outcome variables, Average of Exam Scores, Team Activity Score, and Total CDE Score, were developed to analyze the inferential statistics of this study.

The third data source consisted of exit-level TAKS mathematics and science scores. Those score sets were state TAKS scores, School TAKS scores, and Team TAKS scores.

Data from these three data sources were interpreted as they relate to the four research objectives.

Research Objective 1 described the participants in the study and explored relationships between interrelated items on the survey instrument. Two-thirds of respondents reported that instruction in agricultural science was related to the CDE. Almost 60% of respondents used graphing calculators on a daily basis. Over 50% of the students described themselves as Competent or Expert users of graphing calculators. Approximately half of the students had been in band, orchestra or choir programs; half of the students had never been in band, orchestra or choir.

Research Objective 2 compared CDE Contest outcomes between teams exposed to mathematics enrichment activities and those that were not. The mean written examination score for teams cooperating in the enrichment activity were 12.32 points higher than non-cooperator teams, a statistically large difference.

The mean Total Individual Skill Score for cooperators was almost 7 points higher than that of non-cooperators. These results fell beyond the pre-determined level of significance. The difference in mean Team Activity Score for cooperators and non-cooperators was not statistically significant.

The mean for Total CDE Score for cooperators was almost 18 points higher than that of non-cooperators, a statistically large difference. The Written Examination score accounted for 71% of the difference in Total CDE score by Team.

Research Objective 3 compared TAKS Exit Mathematics and Science scores, State Agricultural Mechanics CDE scores, level of expertise with graphing calculators, and participation in CDEs between teams exposed to contextual mathematics enrichment activities and those that were not.

The mean Team TAKS Mathematics scores for cooperators and non-cooperators were not significantly different. Cooperators scored 5 points higher than non-cooperators on the 2008 Exit-level Mathematics TAKS. Cooperators scored at the state mathematics mean and above the state CTE mathematics mean in 2008. Cooperators scored at the state science mean in 2008, and above the state CTE science mean in 2008.

Research Objective 4 explored interrelationship between TAKS Exit Mathematics scores, State Agricultural Mechanics CDE scores, and participation in fine arts courses between students exposed to contextual mathematics enrichment activities and those that were not.

There were no significant Pearson's correlations for participation in a school band, orchestra or choir and performance on exit-level mathematics or science TAKS assessments. There were no significant Pearson's correlations between grade level of participation in school band, orchestra or choir and performance on exit-level mathematics or science TAKS assessments. Members of band, orchestra or choir at lower grades were less likely to have passed the exit mathematics TAKS assessment. A one way analysis of variance between participation in fine arts courses and cooperation status was not significant. A one way analysis of variance between the grade level of participation in fine arts courses and cooperation status was not significant.

# CHAPTER V

# SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

## SUMMARY

The study produced a series of findings regarding contextual mathematics and authentic assessment. The two questions offered in the problem statement were, will these enrichment activities improve individual and team performance on the Agricultural Mechanics Career Development Event? And will these same enrichment activities improve student learning in mathematics?

The findings of this study suggest that enrichment activities do improve individual and team performance on the Agricultural Mechanics Career Development Event. Cooperating schools increased their average team score by 18 points and their average exam score by 12 points. There were no significant differences in the team activity score between cooperators and non-cooperators.

These same enrichment activities improve student learning in mathematics by almost five points. Implications relative to being a cooperator in the enrichment activity are numerous and beneficial. Participation is positively correlated to many factors.

The remainder of this chapter is organized in the following manner. The research objectives are stated, followed by conclusions, implications and recommendations for further research and practice, addressing each objective in order.

RESEARCH OBJECTIVES

Research Objective 1 was designed to describe the participants in the study and their responses to items on the questionnaire, and explore the relationships between the participants' demographic characteristics and interrelated items on the survey instrument.

Research Objective 2 was designed to compare CDE Contest outcomes; the Written Examination, Team Individual Skill scores, and Team Activity scores between teams exposed to mathematics enrichment activities and those that were not.

Research Objective 3 was designed to compare Team TAKS Exit Mathematics and Science scores, School TAKS Exit Mathematics and Science scores, Team Composite State Agricultural Mechanics CDE scores, perceived level of expertise with a graphing calculator, and frequency of participation in CDEs between teams exposed to contextual mathematics enrichment activities and those that were not.

Research Objective 4 was designed to explore interrelationship between Team TAKS Exit Mathematics scores, Team Composite State Agricultural Mechanics CDE scores, and participation in fine arts courses between students exposed to contextual mathematics enrichment activities and those that were not.

## CONCLUSIONS OF RESEARCH OBJECTIVES

Research Objective 1: describe the participants in the study and their responses to items on the questionnaire, and explore the relationships between the participants' demographic characteristics and interrelated items on the survey instrument.

In Question 1, respondents were asked to identify the agricultural science classes in which they had enrolled, from a list of the fifteen AFNR classes with the highest enrollments and an "other" option. Almost 80% of respondents completed Introduction to Agricultural Science and Technology (AGSC 101), 56% completed Metal Fabrication (AGSC 322) and 67% completed Introduction to Agricultural Mechanics (AGSC 221).

In Question 2 of the survey, respondents were asked to indicate how closely the agricultural mechanics CDE related to their secondary agricultural science instruction. Over 70% of the respondents indicated that their classroom instruction was related to the CDE. Students perceived that the CDE measured their classroom instruction.

In Question 3, respondents identified a career pathway which most closely described his/her career choice. Almost 40% of respondents identified power, structural and technical systems as their career choice. Almost as many undecided students as committed agricultural mechanics students participated in the CDE.

In Question 4, respondents were asked to identify the high school mathematics courses they had completed. Respondents indicated that 95% had taken Algebra I and Geometry, and over 80% had taken Algebra II, the most commonly taken mathematics courses required for graduation. Equal numbers had taken AP Calculus and Mathematics Models with Applications, a contextual mathematics course. The majority of mathematics course-taking was limited to the 3 preferred mathematics courses – Algebra I, Algebra II, and Geometry. Fewer students selected contextual mathematics courses as electives. Fewer students selected contextual mathematics courses as electives, but one student in 6 had taken a mathematics course not on the list of preferred choices.

The current TEKS revision process is recommending the incorporation of discipline-specific contextual mathematics and science courses as an acceptable component of the 4 X 4 graduation plan. It is hoped that in the approval process, these courses will actually be contextual, and designed to enhance student learning and problem-solving skills (Suydam, 1990), rather than remedial, and designed to serve as reinforcement classes for end-of-course examinations in science and mathematics.

Implications relative to the course Mathematical Models with Applications may impact a variety of areas. The proposed incorporation of contextual mathematics courses into the 4 X 4 graduation plan can provide more appropriate career pathways and options for students. Increased enrollments in courses with contextual frameworks such as Mathematical Models or others yet to be identified can result in improved student achievement in mathematics. Closer cooperation between subject matter specialists in mathematics, science, and AFNR will result in a wider assortment of professional development opportunities designed to improve achievement among a broader spectrum of the student population.

Current mathematics and science course sequencing options are excessively prescriptive. Scheduling options lack opportunities for students to enroll in contextual mathematics courses at grade levels where integrated instruction may be more effective. Students would experience significant improvement in overall mathematics, science, and CTE achievement when contextual learning is present across a district's curriculum (Lindner, Edney & Jones, 2003).

Five questions dealt specifically with graphing calculators. Almost all respondents (95%) used graphing calculators at school; 60% used calculators at school daily, while 30% used calculators as needed. Half of the respondents were competent calculator users and 30% reported an intermediate skill level. Equal numbers were novices and experts.

Apparently graphing calculators are more often used in the 4$^{th}$ year, or advanced, mathematics courses; this may be too late. The TAKS exit assessment is administered at the 11$^{th}$ grade. Students need significantly more practice with graphing calculators at the 9$^{th}$, 10$^{th}$, and 11$^{th}$ grade levels. Graphing calculator use is especially critical during enrollment in Algebra I, a gateway course for higher mathematics. The TAKS exit level mathematics assessment focuses on skills covered in Algebra I. The findings suggest that ownership of a graphing calculator is more closely related to expertise, and success in mathematics, than using a calculator at school. This mirrors the findings of a survey conducted in conjunction with the 2003 Texas FFA State Agricultural Mechanics CDE (Lindner, Edney & Jones, 2003). Graphing calculators are readily available at office supply stores, electronics stores, and discount stores. They are often prizes in some agriscience fairs and agricultural mechanics project shows.

Question 8 disclosed that half of the respondents owned graphing calculators. This mirrors the findings of previous studies (Lindner, Edney & Jones, 2003; Heller, Curtis, Jaffe & Verboncouer, 2005). Over 95% of respondents own calculators from Texas Instruments. In the pilot survey, 47% indicated ownership of graphing calculators; over 80% of those owned TI 83/84 calculators. From 2003 to 2008, student ownership of graphing calculators did not exceed 50%; ownership numbers are not increasing. In the marketplace of high school students, competing technologies such as laptop computers and smart phones may be replacing graphing calculators. When personal expenditures are considered, Texas Instruments brand graphing calculators are the required regional choice.

Question 10 asked respondents to report their expected grade in mathematics. Over 90% reported making As and Bs. Above-average mathematics grades were equally distributed among all respondents. There was no distinct advantage for mathematics scores for any team member.

Question 11 asked respondents to identify the high school science classes they had completed 1. Over half had taken Integrated Physics and Chemistry, Biology I, and Chemistry. Only 6% had taken AP Physics and 5% had taken Principles of Technology; contextual science courses that have some applicability to this CDE. Student course-taking is focused on the three required science courses. Students are seldom encouraged to take contextual science courses. However, the findings suggest that students appear to choose contextual science courses more frequently than contextual mathematics courses.

Questions 12 and 13 dealt with students' personal expectations regarding team and individual placing. The mean anticipated team placing (Question 12) was 8.32; the average team expected to place in the top 10. Many experienced agriscience teachers who work hard at training agricultural mechanics CDE teams have the baseline goal of placing their team in the top 10. Over 1/3 of team members expected their teams to place in the top 5.

The mean anticipated individual placing (Question 13) was 28.34; the average participant expected to place in the top 1/4. An individual placing of 39$^{th}$ would still put the respondent in the top 1/3 of all participants. Many career development events provide awards for the top five or top 10 high-point individuals.

Bandura's social learning theory may provide insight into these results. Bandura posits that much of human behavior is learned by observation (Bandura, 1977). These observations are incorporated into an individual's thought processes, and may be imitated, discarded, or modified based on self-need. As a result of this self-need, individuals validate their personal effectiveness, or self-efficacy, based on a variety of factors. Self-efficacy provides a feeling of control over external factors, to the extent that successfully completing the enrichment activity increased the self-efficacy of cooperators. Individuals with a high level of self-efficacy tend to attempt more, achieve more, and are more persistent than those with low self-efficacy. Bandura feels that individuals with high self-efficacy tend to have a greater degree of control over their situation, and suffer less from uncertainty. Some call this concept self-confidence. Bandura's social learning theory is also reflected in Lave and Wenger's concept of legitimate peripheral participation. Students participating at this competitive level have a certain degree of self-confidence. As they develop this confidence, they become more expert learners, and are more adept at performing higher-level tasks. Participation in the enrichment activity provided that increased level of learning for cooperating students.

Question 14 dealt with previous participation in agricultural mechanics CDEs. Over half of the students had participated in 3 or fewer agricultural mechanics CDEs. There was no implicit advantage from repetitive CDE participation. This does not sustain Johnson's finding (1993) that previous CDE experience positively impacted student achievement.

Question 15 related to student participation in the Texas FFA Tractor Technician CDE. Three-fifths indicated they had not previously participated in that CDE. There was no distinct advantage for students who had participated in the Tractor Technician CDE. Students who had participated in the tractor technician CDE were more likely to have taken fewer agricultural mechanics courses. This may reflect school scheduling practices; many students who participate in this CDE tend to be enrolled in pre-employment laboratory classes, which may be double-period classes, but were counted as 1 class. Students who had participated in the tractor technician CDE were more likely older, and had taken fewer mathematics or contextual science courses, since the 4 X 4 requirement would not have applied to them. Participation in the tractor technician CDE could serve as a pipeline to participation in the agricultural mechanics CDE. Students who have participated in the tractor technician CDE may have a higher degree of self-efficacy when participating in the agricultural mechanics CDE, due to similarities between the two events. It is possible that successful participation in the tractor technician CDE can generate interest in the agricultural mechanics CDE. Both events occur in the same semester, and opportunities for participation exist.

Question 16 asked students to self-report their perceived classroom performance in agricultural mechanics. The majority of respondents expected to earn an A in agricultural mechanics courses. Teams and individuals were evenly distributed in regards to academic ability in agricultural mechanics. A positive correlation between agricultural mechanics grade and ownership of a graphing calculator indicates that owning a graphing calculator may have a small positive effect on agricultural mechanics grade**.**

Question 17 asked participants to self-report their overall GPA, 80% reported A's and B's. No team had a distinct advantage in expected mathematics grade. A negative Pearson correlation between self-reported overall GPA and Question 24, participation in band, orchestra or choir indicated that performance fine arts participation has a small ($r$ = -.23, $p$ = .045) positive effect on student overall GPA.

Questions 18, 19 and 20 dealt with student performance on Mathematics TAKS assessments. The 2008 Mathematics TAKS assessments were administered the week following the State Agricultural Mechanics CDE. The data reflected tendencies to steer average students away from contextual science courses such as Integrated Physics and Chemistry (IPC) or Principles of Technology (PT). This is an indicator of conventional attitudes that integrated or contextual learning is doing some students more harm than benefit. Students in jeopardy of not mastering the TAKS assessments are discouraged from co-curricular contextual STEM activities, like the agricultural mechanics CDE, when these very activities might provide a more effective assessment of knowledge and skills than standardized test scores.

Question 21 identified the majority of students as juniors or seniors. This confirms that the majority of students had not mastered the TAKS exit assessment as of the CDE date.

Questions 22 and 23 ascertained that over 2/3 of respondents were European American, and 10% were Hispanic American. These numbers mirror statewide AFNR enrollment, but not statewide CTE enrollments (Texas Education Agency, 2003; Lavergne, 2008). Statewide CTE enrollments include 10% African American and 27% Hispanic American students.

Question 24 indicated that 70% of respondents were never or no longer enrolled and less than 10% were currently enrolled in band, orchestra or choir programs. The negligible positive correlation between performance fine arts participation and perceived overall GPA indicates that high positive correlation reported between performance fine arts and higher academic achievement was not supported by this study.

Question 25 addressed those respondents who reported being currently or formerly in band, orchestra or choir programs. Only half of the respondents were currently a member of band, orchestra or choir programs. The fourth course option available to high school students for satisfying the fine arts graduation requirement is studio art of some fashion. Enrollment in this course is not reflected in the data. This aligns with data indicating that over half of the secondary students in Texas enroll in traditional studio art programs at the secondary level, not high-visibility performing arts as the media often suggest. The negative correlation ($r$ = -.34, $p$ = .046) between grade level of band, orchestra, or choir participation, and mastery of the TAKS exit mathematics assessment indicates that the benefits of participation in performance fine arts are achieved at the lower grade levels, and that repetitive participation in performance fine arts from elementary through high school may actually have a negative impact on mastery of TAKS objectives.

Statistical analyses of the nine developed outcome variables indicated no difference between cooperators and non-cooperators based on these nine variables, affirming that team members were not significantly different on mathematics or science ability, or any of the other intervening variables. There was no cherry-picking of team members to participate in the enrichment activities.

Research Objective 2 compared CDE Contest outcomes; the Written Examination, Team Individual Skill scores, and Team Activity scores between teams exposed to mathematics enrichment activities and those that were not.

Cooperation status had a large effect on 2008 written examination score. For the 2008 State Agricultural Mechanics CDE, cooperating teams scored 12.32 points higher than non-cooperating teams; a score increase generally adequate to change the outcome of most career development events. The significance of cooperation status or participation in a directed study group on student achievement in mathematics is supported by the findings of Rittle-Johnson and Kmicikewycz (2008).

The maximum total score on the state agricultural mechanics CDE is 600 points per 3-member team; the maximum total individual score is 295. The winning team in 2008 scored 504, or 72.5% of the maximum total score. The average individual score on the winning team was 168.

The difference in Written Examination scores between cooperators and non-cooperators by Team, found by summing the average scores of the three members per team, would be 36.96 (12.32 X 3). The difference in the average Total CDE Score between cooperators and non-cooperators by Team was found to be 52.26. The Written Examination score accounted for 71% (36.967.11 / 52.26) of the variability in Total CDE score by Team. Gliem and Warmbrod (1986) previously identified the positive relationship between CDE achievement and mathematics achievement, this study supports their finding.

The mean for Total Individual Skill Score for cooperators was 44.52, almost 7 points higher than that of non-cooperators. However, these results were beyond the pre-determined level of significance of .05 ($p$ = .054). Cooperator status may have had some additive effect on the Individual Skill Scores. Individual members of cooperating teams, based on a 3-member team, scoring 7 points higher than non-cooperators on the Individual Skills portion of the CDE can change the outcome (7 X 3 = 21) of an event. While not statistically significant, this 7-point difference did contribute to differences found between average Total CDE Score.

Cooperation status had a large effect on 2008 Team CDE Rank. Since CDE ranking is inversely scored, participating in the contextual mathematics enrichment benefitted cooperating schools by improving their rankings an average of 8 places.

Cooperation status had a large effect on 2008 Team Total CDE Score. The mean total numeric score of cooperating teams was 420.38, 52 points above the mean of non-cooperating teams. Since total CDE scores are positively associated with final placing, the contextual mathematics enrichment benefitted cooperating schools by improving their total numeric scores an average of 52.25 points by team, or by 17 points per individual.

The mean Team Activity Score for cooperators was 26.08; the mean for non-cooperators was 28.0. The difference in the means of cooperators and non-cooperators of 1.92 was not statistically significant. Participation in enrichment activities had no effect on team activity score.

Univariate analyses of variance were conducted to compare written examination score with use of graphing calculators at school, frequency of graphing calculators use, level of expertise with graphing calculators, graphing calculator ownership and cooperation status showed that both groups used graphing calculators at school on a weekly basis, were similar in expertise, equally likely to own graphing calculators and that any effect size was small. Cooperators and non-cooperators are similar in many respects.

The univariate analysis of variance conducted to compare written examination score and self-reported mathematics grade and cooperation status indicates that both groups were similar in mathematical ability and confidence level.

The univariate analysis of variance conducted to compare written examination score with self-reported agricultural mechanics grade and cooperation status confirmed that both groups generally make A's in agricultural mechanics classes.

The univariate analysis of variance conducted to compare written examination score with self-reported overall average GPA and cooperation status demonstrated that both groups report a B for their overall GPA; they are not different in this aspect.

The univariate analysis of variance conducted to compare written examination score with level of competition in agricultural mechanics CDEs and cooperation status identified no advantage due to participation in numerous agricultural mechanics CDEs. The groups are not different.

The univariate analysis of variance conducted to compare written examination score with current grade level and cooperation status demonstrated that both groups are predominantly composed of high school juniors.

Cooperation status had a definite and decided effect on outcome. Some of this effect may be based on Bandura's social learning theory (1977). Observations are incorporated into an individual's thought processes, and may be modified based on self-need. As a result of this self-need, individuals validate their self-efficacy based on a variety of factors. Self-efficacy provides a feeling of control over external factors. Individuals with a high level of self-efficacy tend to attempt more, achieve more, and are more persistent than those with low self-efficacy. Social learning theory is reflective of Lave and Wenger's concept of legitimate peripheral participation. Students who benefitted from enhancement activities may have increased their self-efficacy.

Teachers who commit to participating in in-service workshops for contextual mathematics and incorporate these concepts into daily instruction can expect score improvements in competitive activities (CDEs) that have significant mathematics components. Improvements in individual and team written examination scores, individual skills, and overall team rankings will result from an emphasis on contextual mathematics. Student self-efficacy may increase, and improvements in the problem-solving skills of students will expand into a variety of efforts.

With a focus on the budget, school administrators may perceive student participation in career development events as a luxury item. These co-curricular events require some investment in both instructional time and educational resources. Teachers may involve students in focused training sessions after the end of the typical school day. Specialized events may require that specialized equipment be utilized in the training process. Additionally, both the teacher and students may need to be off campus on regular school days to compete in the CDEs. These practices may be perceived as less-than-optimal uses of public resources, particularly in a time of continuing calls for greater school accountability. Justification of these expensive and time-consuming activities may be increasingly important. Secondary AFNR programs are increasingly called upon to contribute to the bottom line of school improvement. One way to make this contribution is to enhance the mathematics and science performance on standardized assessments. In some locales, school districts may opt to place students in remedial courses rather than contextual learning situations. Negligible score improvement on standardized mathematics assessment may occur at the expense of participation in career development events. Contextual learning provides more permanent learning than short-term remediation.

As the call for educational accountability continues, educational organizations and school districts should call for the consideration of contextually-based, content-rich problem-solving career development events as end-of-course assessments (Texas Instruments, 2003c). A pilot program process can be utilized to identify options for authentic assessment in specific venues.

Consideration should be given to replication of this study at a national level. The National FFA Foundation could provide necessary funding for the development of contextual mathematics problems and provision of enhancement opportunities to interested states. This study could also be replicated with various other career development events with varying event structures. Contextual problems appropriate for multiple disciplines can be developed and tested. A greater research effort should be expended to investigate the relationships between CTSO participation and student leadership. Involving other national organizations in the study could prove beneficial (Zirkle & Connors, 2003).

Research Objective 3 compared Team TAKS Mathematics and Science scores, School TAKS Mathematics and Science scores, Team Composite State Agricultural Mechanics CDE scores, perceived level of expertise with a graphing calculator, and frequency of participation in CDEs between teams exposed to contextual mathematics enrichment activities and those that were not.

School TAKS Mathematics and Science Scores of cooperators and non-cooperators were not significantly different; team members were not selected based on mathematics or science ability. Cooperator schools are performing at the State TAKS Mathematics Mean; both groups represent schools performing above the state CTE TAKS mean.

The five-point difference between the Team TAKS Mathematics scores for cooperators and non-cooperators indicates that members of cooperating teams increased their TAKS exit mathematics scores an average of 5.01 points. Although 5 points may seem minimal, this improvement is significant to a school working to improve TAKS mathematics scores. An increase of 5 points per individual may be adequate to change the accountability rating of a school. This type of increase is reflected in AYP, and can move a school from Academically Unacceptable to Academically Acceptable, from Academically Acceptable to Recognized. Schools interested in improving TAKS exit mathematics scores should place a higher value on contextual learning opportunities. This supports Heller, Curtis, Jaffe and Verboncouer's (2005) findings regarding the importance of calculator use in mathematics assessment and student achievement.

Implications relative to the five-point increase in TAKS exit-level mathematics scores are significant as well. A five-point score increase in mathematics per student is sufficient to move some districts to the next highest accountability rating level. School districts expend large sums on professional development focused on improving student achievement scores. A five-point increase resulting from contextual teaching and learning will result in improved cost efficiency. Texas and other states continue to address student achievement issues related to AYP and federal legislation (Briggs, 2009). Many of the most-often missed TAKS objectives are dependent upon students' conceptualization skills (Silvey, 2007). Improvement is still necessary in mathematics and science, and content in objective areas dealing with STEM, particularly Algebra and Geometry, may be best reinforced by contextual teaching and learning (Laird & Kahler, 1995).

The findings of this study reinforced the need to further incorporate the use of graphing calculators in both day-to-day instruction and in contextual settings. Students have ready access to graphing calculators, and they are mandated for the TAKS exit mathematics and science assessments. Continued use of graphing calculators in scenarios meaningful to students will improve achievement further. Frequent instruction involving graphing calculators should be present at lower grade levels than occurs today. Professional development offerings for teachers should continue to address strategies for utilizing graphing calculators in learning environments.

Consideration should be given to submitting this concept and problem set to the USDE What Works Mathematics Clearinghouse. There are no examples of curriculum-based interventions for increasing mathematics achievement at the high school level. This study should be considered for inclusion, due to the evidence-based results obtained from scientific research (Institute of Educational Sciences, 2004).

Cooperators scored 65 points higher than the TAKS Science Mean of students from their respective schools. Cooperators scored 70 points above the State TAKS Science Mean, and 80 points above the State CTE Science Mean. Apparently, participation in contextually-grounded CDEs, couched as authentic assessment opportunities, does not impair student performance when these activities are conducted out-of-district during the school day.

Bell (1977), Roberts (1980) and Waxman, Williams and Bright (1994) emphasized the need for studies that include assessments of contextual learning requiring the use of graphing calculators. They recognized the importance of situated cognition, improved pre-service and in-service training for teachers, and call for greater experimental research in this and other areas of calculator-based mathematics. The National Mathematics Advisory Panel also recommends further study of graphing calculator use for problem-solving, conceptual understanding, and mathematical operations (2008).

It is possible that some improvement in TAKS scores, or in the written examination, may be due to the influence of reactivity. Some literature identifies this as the Hawthorne effect. Students who were identified as cooperators may have been encouraged to give their best efforts due to the fact that they were participating in a research study. The reactivity effect has some relationship to Lave and Wenger's position on cultural learning. However, students participating in this CDE reached this level of participation due to personal and group expertise; cooperators and non-cooperators alike were already intrinsically motivated to perform at a higher level. Also, school districts go to significant lengths to encourage students to perform well on TAKS assessments, especially the exit-level assessment.

A cursory review of contextual mathematics textbooks shows two distinct types of content topics. These resources provide instruction in the topics of operations, such as whole numbers, fractions, and decimals, and applications, such as measurements, formulas, and graphing. Strong consideration should be given for inclusion of a third type of problem set in these resources. Topics and courses for contextual applications should be added to enhance student understanding and provide depth of learning in mathematics (Bell, 1977). These problem sets should be designed to provide opportunities for analysis of complex situations, such as the team activity in the agricultural mechanics CDE.

As Texas and other states contemplate the adoption of end-of-course assessments for CTE courses, consideration should be given to examining the effectiveness of inclusion of state-level career development events that incorporate authentic assessment activities. These CDE scores could be used in lieu of traditional assessments for schools qualifying to participate at this level. Schools choosing to discourage participation in authentic assessment events should be provided the mandated traditional text-based examinations.

A replication of this study should involve the assignment of normed values to schools based on current mathematics commendation status. Some schools may already be high-performing in mathematics, while others may be struggling to make progress in improving mathematics scores.

Consideration should be given to replication of this study with a greater focus on diversity. A related study found that contextual mathematics problems incorporated into AFNR classroom instruction did provide a slight increase in student achievement for some ethnic groups (Jasek, 2005). Efforts should be made to identify states where greater ethnic and gender diversity is represented in the participants of the agricultural mechanics CDE.

The Office of Adult and Vocational Education (OVAE, USDE) should make a stronger case to the Institute for Educational Science (IES) regarding the inclusion of contextual learning research. States continue to struggle with assessments that are effective and rigorous (Briggs, 2009). The process utilized in this study is not necessarily the only method useful for improving student achievement in mathematics, but it has proven to be effective (Stone, Alfeld, Pearson, Lewis & Jensen, 2006). When panels of nationwide relevance are assembled to develop far-reaching significant reports, care should be taken to either reconcile or incorporate previous positions from differing audiences (National Council of Teachers of Mathematics, 1989; U.S. Department of Labor, 1991; National Mathematics Advisory Council, 2008). Contextual learning will likely continue to be a leading research topic (Pivnichny, Wichowski, and Heberly, 2007).

Research Objective 4 explored the interrelationships between Team TAKS Mathematics scores, Team Composite State Agricultural Mechanics CDE scores, and participation in fine arts courses between students exposed to contextual mathematics enrichment activities and those that were not.

Participation in fine arts courses and cooperation status were not significantly related. Both groups were composed of individuals of equal participation in fine arts.

Participation in a school band, orchestra or choir yielded no significant relation to performance on exit-level mathematics or science TAKS assessments.

The negative low relationship between overall GPA and participation in band, orchestra or choir, since the item was scored inversely, indicates that students who had participated in band, orchestra or choir at the lower grades were slightly more likely to have higher overall GPAs.

A moderate negative relationship between participation in fine arts grade level and passing the exit mathematics TAKS assessment suggests that students who had been members of band, orchestra or choir programs at the lower grades were less likely to have passed the exit mathematics TAKS assessment.

The Texas legislature, in May 2009, approved revisions to the state-mandated public high school graduation plans. In those revisions, requirements for technology applications and speech communications were eliminated. However, the mandated credit for secondary fine arts was retained, and a fine arts course at the middle school level was mandated to begin in 2010. These two mandates for fine arts curriculum run counter to the findings of this study, and will do little to enhance the state's ability to develop a high-skills workforce (U. S. Department of Labor, 1991). Some research claims achievement advantages based on four years of fine arts participation at the secondary level as opposed to ½ year or less. Studies claiming the advantages of four years of secondary fine arts participation may have cherry-picked the participants; these results may not be generalizable to the typical student population. This cannot be realistically applied to all Texas situations. Currently, all students continue to take a minimum of 1 credit of secondary fine arts education in Texas.

The findings of this study conflict with contemporary research regarding the efficacy of the arts on improving student achievement. Consideration should be given to conducting gold-standard research examining the efficacy of fine arts education. A need exists for studies to investigate the impact of performance fine arts upon TAKS exit examination scores or end-of-course scores rather than SAT scores. Findings should be generalizable to a larger, more representative number of students. A review of fine arts literature revealed some misquoting of report titles and lack of clarity in relating report findings. Also, further review indicates that participants in some studies showing the highest positive impacts of performance based fine arts have been selectively, rather than randomly, chosen.

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# APPENDIX A

## STUDENT ENRICHMENT ACTIVITY PROBLEM SET

**EVALUATING THE MATHEMATICS ACHIEVEMENT LEVELS OF SELECTED GROUPS OF STUDENTS PARTICIPATING IN THE TEXAS FFA AGRICULTURAL MECHANICS CDE**

**Problem #1: Comparing Equipment Rental Costs**

**Course:** **Agriscience 323 – Agricultural Power Technology**

**TEKS:** **323 – c(1)B, c(2)A (state curriculum standard)**

**Math Exit TAKS objective 3** **understanding linear functions, slope & intercept**

There are two tractor rental offers. In the first offer, you must pay $100 down payment and then $50 for each month of use. The second offer has a $75 down payment and then $55 dollars for each month of use. After which month is the first offer a better deal?

a) 2
b) 3
c) 4
d) 5
e) none of the above

**Correct Answer:_____**

**Problem #2: Poultry Nutrition**

**Course:** **Agriscience 231 – Plant & Animal Science**
**Agriscience 332 – Animal Science**

**TEKS:** **c(3)A**

**Math Exit TAKS objective 1** **Describing functional relationships**

Different types of poultry feed provide varying levels of energy, measured in megacalories (Mcal), for different prices. The table below shows four available products. What is the most cost efficient (most megacalories per dollar of cost) feed available?

A) Ground wheat
B) Corn
C) Rice bran
D) Grain sorghum

| Feed Type | Energy Value | Cost |
|---|---|---|
| Ground wheat | 152 Mcal/CWT (100 lb) | $14/CWT |
| Corn | 176 Mcal/CWT | $8/CWT |
| Rice bran | 1780 Mcal/ton | $70/ton |
| Grain sorghum | 2040 Mcal/ton | $100/ton |

**Correct Answer:_____**

**Problem #3: Calculating Fuel Efficiency**

**Course: Agriscience 323 – Agricultural Power Technology**

**TEKS: c(3)A**

**Math Exit TAKS objective 1 Describing functional relationships (rate)**

**A survey was conducted to measure fuel consumption, in gallons per hour, of a delivery truck at various speeds. Using the data collected, at which speed, in mph, does the truck consume the least gallons of fuel per mile?**

A) 40 mph
B) 50 mph
C) 60 mph
D) 70 mph

| Speed (MPH) | Fuel consumption per hour |
|---|---|
| 10 | 0.9 |
| 20 | 1.2 |
| 30 | 1.4 |
| 40 | 1.7 |
| 50 | 2.0 |
| 60 | 2.5 |
| 70 | 2.9 |

**Correct Answer:_____**

## Problem #4: Growing Replacement Heifers

**Course:** Agriscience 332 – Animal Science

**TEKS:** c(7)B

**Math Exit TAKS objective 10** **Understanding mathematical tools and processes used in problem solving**

During each month of a heifer's growth, her hip height increases by a certain amount. The hip height of a "Frame Score 7" heifer was recorded monthly for six months. Height measurements were taken on the first day of each month. During which month was the growth the fastest?

A) 6 Months
B) 7 Months
C) 10 Months
D) 11 Months

| Age (months) | Hip height (inches) |
|---|---|
| 6 | 46.5 |
| 7 | 47.3 |
| 8 | 48.4 |
| 9 | 49.0 |
| 10 | 49.7 |
| 11 | 50.4 |

**Correct Answer:_____**

## Problem #5: Median Temperature

**Course:** **Agriscience 231 – Plant & Animal Science**
**Agriscience 231 – Agricultural Structures**
**Agriscience 332 – Animal Science**

**TEKS:** **362 – c(4)D; 364 – c(2)C**

**Math Exit TAKS objective 9** **Understanding percents, proportional relationships, probability, and the application of statistics**

Growers want to minimize heating and cooling costs in growing houses, but still must ensure that the birds will tolerate the temperatures of the region. Temperatures are measured at noon for several days and recorded in the table below. What is the median temperature over this period?

| **Date** | **Daily Temperature** |
|---|---|
| Monday | 75 |
| Thursday | 86 |
| Sunday | 90 |
| Wednesday | 89 |
| Saturday | 85 |
| Tuesday | 82 |

a) 85.5
b) 88.3
c) 85.0
d) 82.7
e) 84.0

**Correct Answer:_____**

## Answer Key for Problems

| Problem Description | Answer |
|---|---|
| Comparing Equipment Rental Costs | D |
| Poultry Nutrition | C |
| Calculating Fuel Efficiency | B |
| Growing Replacement Heifers | B |
| Median Temperature | A |

***Acknowledgements***

*Susan Larson, A+ Math Consulting*
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*Kirk Edney, Instructional Materials Service, Texas A&M University,*
*developed, revised, edited, and field-tested this problem set.*

Mathematics in Context 2008

# APPENDIX B

# STUDENT INFORMATION SHEET

**STUDENT INFORMATION SHEET**

**Evaluating the Mathematics Achievement Levels of Selected Groups of Students participating in the Texas FFA Agricultural Mechanics Career Development Event**

## Introduction

You have been asked to participate in a research study relating to mathematics achievement and the Texas FFA agricultural mechanics career development event. You were selected because you qualified to compete in the 2008 Texas FFA State Agricultural Mechanics CDE. A total of 120 students have been asked to participate in this study. We are doing this study to evaluate student mathematics achievement relative to competition in the CDE.

## What will I be asked to do?

If you agree to participate in this study, you will be asked to complete a two-page survey consisting of approximately twenty-five questions. This survey will take approximately ten minutes to complete, and will be given after the written examination of the Texas FFA State Agricultural Mechanics CDE on Friday, April 25, 2008. The second part of the study will consist of an anonymous sharing of your exit-level mathematics TAKS scores with me. I will ask your school to provide me a copy of your TAKS score report, with your name and other identifying information removed.

## Do I have to participate?

No. Your participation is voluntary. You may decide not to participate or to withdraw at any time and no one will be upset.

## Who will know about my participation in this research study?

This study is confidential, and participants will be identified by school only. The records of this study will be kept private. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be kept private and stored securely, and only Dr. Tim Murphy and I will have access to the records. No one other than the researchers will know you are involved in the study.

## Is there anything else I should consider?

Your decision whether or not to participate will not affect your current or future relations with Texas A&M University. If you decide to participate, you are free to refuse to answer any questions that make you feel uncomfortable. You can withdraw at any time without your relations with the University, job, benefits, etc. being affected.

## Participation

If you would like to participate, please sign and date your permission form, and return it to me with the completed survey. You keep this information sheet. Thank you for your cooperation and your time.

Sincerely

*Kirk Edney*

Kirk Edney, Principal Investigator
Department of Agricultural Leadership, Education and Communications
Texas A&M University

# APPENDIX C

# PARENTAL CONSENT FORM

## PARENTAL CONSENT FORM

Evaluating the Mathematics Achievement Levels of Selected Groups of Students Participating in the Texas AFFA Agricultural Mechanics Career Development Event

Your child has been asked to participate in a research study relating to mathematics achievement and the Texas FFA Agricultural Mechanics Career Development Event. He / she was selected because he / she qualified to compete in the 2008 State Agricultural Mechanics CDE. A total of 120 students have been asked to participate in this study. The purpose of this study is to evaluate student mathematics achievement relative to competition in the CDE.

If you agree to allow your child to be in the study, participation consists of two parts. In the first part, your child will be asked to complete a two-page survey consisting of approximately twenty-five questions. The survey will take about ten minutes to complete, and will be given after the written examination of the Texas FFA Agricultural Mechanics CDE on Friday, April 25, 2008.

The second part of the study will consist of an anonymous sharing of your child's exit-level mathematics TAKS scores. If you consent, I will ask my child's school to provide me a copy of your child's TAKS score report, with his / her name and other identifying information removed.

The risks of this study are minimal, and probably limited to the loss of time expended to complete the survey. There are no benefits to participating in this study. Neither your child nor you will receive compensation or reimbursement for participating in this study.

This study is anonymous, and participants will be identified by school only. The records of the study will be kept private. No identifiers linking your child to this study will be included in any sort of report that might be published. Research records will be stored securely, and only Dr. Tim Murphy and Kirk Edney will have access to the records. Your decision whether or not to allow your child to participate will not affect your or his / her current or future relations with Texas A&M University. If you decide to allow your child to participate, he / she is free to refuse to answer any questions that make him / her feel uncomfortable. He / she can withdraw at any time without his / her relations with the University, job, benefits, etc. being affected.

This research study has been reviewed and approved by the Institutional Review Board – Human Subjects in Research, Texas A&M University. For research-related problems or questions regarding subject's rights, contact the Institutional Review Board through Ms. Angelia M. Raines, Director of Research Compliance, Office of the Vice-President for Research at (979) 458-4067, araines@vprmail.tamu.edu.

For any other questions about this study, you may contact Kirk Edney at (979) 845-6654 kc-edney@tamu.edu or Dr. Tim Murphy at (979) 862-3419 tmurphy@tamu.edu.

You have read the above information. You have asked questions and have received answers to your satisfaction. You have been given a copy of this consent document for your records. By signing this document, you consent to allow your child to participate in this study.

Signature of Participant: ____________________________ Date: _____

Signature of Investigator: Kirk Edney Date: April 18, 2008

# APPENDIX D

# STUDENT QUESTIONNAIRE

**2008 Texas FFA State Agricultural Mechanics CDE Student Information Sheet**

School ____________________

| NOTE: ALL INFORMATION IS CONFIDENTIAL AND WILL NOT BE REPORTED AS INDIVIDUAL DATA |
|---|

1. Check all of the agricultural science classes in which you have been enrolled:

| | | | |
|---|---|---|---|
| ☐ Intro Ag | ☐ Applied Ag | ☐ Intro Ag Mech | ☐ Wildlife |
| ☐ Plant & An Sci | ☐ Intro Hort. | ☐ Personal Skills | ☐ Ag Structures |
| ☐ Welding | ☐ Ag Power | ☐ Ag Mech Lab | ☐ Equine |
| ☐ Ag Electronics | ☐ Home Maintenance | ☐ Tractor Lab | ☐ Other ag class |

2. How does the Ag. Mechanics CDE relate to your high school agriscience instruction?
   - ☐ Directly related to what we study in class
   - ☐ Indirectly related to what we study in class
   - ☐ Little relationship to our classes
   - ☐ No relationship to our classes

3. Check one pathway that best describes your career choice:

| | |
|---|---|
| ☐ Food Products & Processing | ☐ Power, Structural & Technical Systems |
| ☐ Agribusiness Systems | ☐ Leadership Development Systems |
| ☐ Plant / Horticulture Systems | ☐ Communications Systems |
| ☐ Animal Systems | ☐ Environmental Service Systems |
| ☐ Natural Resources Systems | ☐ Other / Undecided ___________ |

4. Check all high school mathematics classes you have completed:

| | | |
|---|---|---|
| ☐ Algebra I | ☐ Algebra II | ☐ Pre-calculus |
| ☐ Geometry | ☐ Math Models | ☐ AP Calculus |
| ☐ AP Statistics | ☐ Pre-AP Calculus | ☐ Other |

5. Do you use a graphing calculator at school? ☐ YES ☐ NO

6. How frequently? ☐ Daily ☐ Weekly ☐ Monthly ☐ As required

7. What do you consider your level of expertise with a graphing calculator?

   ☐ Novice ☐ Intermediate ☐ Competent ☐ Expert

8. Do you own a graphing calculator? ☐ YES ☐ NO

9. If yes, what brand and model do you own? _________________

10. In mathematics courses, you generally make a/an:

    ☐ A ☐ B ☐ C ☐ D

11. Check all high school science classes in which you have enrolled:

- ☐ Principles of Technology
- ☐ Biology I
- ☐ Physics
- ☐ Human Anatomy & Physiology
- ☐ Chemistry
- ☐ AP Physics
- ☐ Integrated Physics & Chemistry
- ☐ AP Environmental Science

12. Your best estimate of your **teams' final placing** in the State Ag. Mechanics CDE?
_____ out of 30 teams.

13. Your best estimate of your **individual placing** in the State Ag. Mechanics CDE?
_____ out of 120 individuals

14. You have competed in _____ **agricultural mechanics CDEs**, total, at all levels.

- ☐ 1 - 3
- ☐ 4 - 6
- ☐ 7 - 9
- ☐ 10 or more

15. Have you participated in the tractor technician CDE? ☐ YES ☐ NO

16. In agricultural mechanics courses, you generally make a/an:

☐ A ☐ B ☐ C ☐ D

17. Your overall average GPA is probably a/an:

☐ A ☐ B ☐ C ☐ D

18. Have you taken the 9th grade Math TAKS assessment? ☐ YES ☐ NO

19. You have taken the 10th grade Math TAKS assessment? ☐ YES ☐ NO

20. Have you passed the exit-level Math TAKS assessment? ☐ YES ☐ NO

21. You are currently enrolled in the:

☐ 9th grade ☐ 10th grade ☐ 11th grade ☐ 12th grade

22. Your gender is ☐ Female ☐ Male

23. You consider yourself to be:

- ☐ Native American
- ☐ Asian American
- ☐ African American
- ☐ Hispanic American
- ☐ Caucasian American, not Hispanic origin
- ☐ Other

24. Have you ever been a member of a school band, orchestra, or choir?

☐ Yes, now a member ☐ Never a member ☐ No longer a member

25. You were a member of a school band, orchestra, or choir at what level?

☐ Elementary ☐ Middle School ☐ High School

# APPENDIX E

# PRINCIPAL'S SCORES REQUEST LETTER

May 18, 2008

Educational Leader, Principal
Texas Sample High School
618 Sample Way
Sample, TX 78910-2345

Dear Ms. Leader:

Members of your FFA chapter have been invited to participate in a two-part research study relating to mathematics achievement and the Texas FFA Agricultural Mechanics Career Development Event. Your FFA chapter was selected because the members qualified to compete in the State Agricultural Mechanics CDE. A total of 116 students have been asked to participate in this study, titled

**Evaluating the Mathematics Achievement Levels of Selected Groups of Students Participating in the Texas FFA Agricultural Mechanics Career Development Event**

The second part of the study consists of an anonymous sharing of those members' exit-level mathematics TAKS scores. At this time, I respectfully request your school provide copies of those students' TAKS score reports, with names and other identifying information removed. The students involved and their parents have already consented to this sharing process. I have attached copies of their signed and dated consent forms for your records. Those students participating in the study are:

The risks of this study are minimal, and probably limited to the loss of time expended to copy, remove identifying information, and mail the score reports. There are no benefits to participating in this study. Neither your school nor you will receive compensation or reimbursement.

Participants will be identified by school only. The records of the study will be kept private. No identifiers linking the students to this study will be included in any sort of report that might be published. Records will be stored securely, and only Dr. Tim Murphy and Kirk Edney will have access to the records. Your decision whether or not to provide these score reports will not affect your current or future relations with Texas A&M University. This research study has been reviewed and approved by the Institutional Review Board – Human Subjects in Research, Texas A&M University.

I appreciate you taking time to assist me with this study. I have enclosed a pre-addressed envelope for your use. If you have any questions about this study, please contact Kirk Edney at (979) 845-6654 kc-edney@tamu.edu or Dr. Tim Murphy at (979) 862-3419 tmurphy@tamu.edu. If I may assist you, please feel free to call. Thank you again for your help and cooperation.

Sincerely

Kirk Edney

Department of Agricultural Leadership,
Education & Communications
Texas A&M University

# APPENDIX F

# PRINCIPAL'S INFORMATION SHEET

## PRINCIPAL'S INFORMATION SHEET

### Evaluating the Mathematics Achievement Levels of Selected Groups of Students Participating in the Texas FFA Agricultural Mechanics Career Development Event

Members of your school's FFA chapter have been asked to participate in a research study relating to mathematics achievement and the Texas FFA agricultural mechanics career development event. Your school's chapter was selected because of its competition in the 2008 State Agricultural Mechanics CDE. A total of 110 students from 29 school districts have been asked to participate in this study. The purpose of this study is to evaluate student mathematics achievement relative to competition in the CDE.

Participation in the study consists of two parts. In the first part, CDE participants were asked to complete a two-page survey consisting of approximately twenty-five questions. The survey was given after the written examination of the Texas FFA Agricultural Mechanics CDE on Friday, April 25, 2008. You may request a copy of the survey by contacting me.

The second part of the study consists of an anonymous sharing of the exit-level mathematics TAKS scores of these members with me. The parents and members have already consented to this sharing. Based on their consent, I ask your school to provide me a copy of your child's TAKS score report, with his / her name and other identifying information removed.

The risks of this study are minimal, and probably limited to the loss of time expended to complete the survey, and the time required to copy and mail the score reports. There are no benefits to participating in this study. Neither the parents, members, school, nor FFA chapter will receive compensation or reimbursement for participating in this study.

This study is anonymous, and participants will be identified by school only. Records of this study will be kept private. No identifiers linking specific children to this study will be included in any sort of report that might be published. Research records will be stored securely, and only Dr. Tim Murphy and I will have access to the records. Your decision whether or not to provide the score reports will not affect your current or future relations with Texas A&M University.

This research study has been reviewed and approved by the Institutional Review Board – Human Subjects in Research, Texas A&M University. For research-related problems or questions regarding subject's rights, contact the Institutional Review Board through Ms. Angelia M. Raines, Director of Research Compliance, Office of the Vice-President for Research at (979) 458-4067, araines@vprmail.tamu.edu.

For any other problems or questions about this study, please contact Kirk Edney at (979) 845-6654 kedney1@verizon.net or Dr. Tim Murphy at (979) 862-3419 tmurphy@tamu.edu. Thanks for allowing your child to participate. We appreciate your time and effort.

Sincerely

*Kirk Edney*

Principal Investigator
Department of Agricultural Leadership, Education and Communications
Texas A&M University

# APPENDIX G

# STUDENT QUESTIONNAIRE CODING GUIDE

**2008 Agricultural Mechanics CDE Survey Coding Guide**

1 = Cooperator in enrichment activity 2 = Non-cooperator in enrichment activity

1. Agricultural science class enrolled:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Intro Ag | 2 | Applied Ag | 3 | Intro Ag Mech | 4 | Wildlife |
| 5 | Plant & An Sci | 6 | Intro Hort. | 7 | Personal Skills | 8 | Ag Structures |
| 9 | Welding | 10 | Ag Power | 11 | Ag Mech Lab | 12 | Equine |
| 13 | Ag Electronics | 14 | Home Maintenance | 15 | Tractor Lab | 16 | Other ag class |

2. Ag. Mech CDE relates to high school agriscience instruction
   1 Directly related to what we study in class
   2 Indirectly related to what we study in class
   3 Little relationship to our classes
   4 No relationship to our classes

3. Pathway that describes career choice:

| | | | |
|---|---|---|---|
| 1 | Food Products & Processing | 6 | Power, Structural & Technical Systems |
| 2 | Agribusiness Systems | 7 | Leadership Development Systems |
| 3 | Plant / Horticulture Systems | 8 | Communications Systems |
| 4 | Animal Systems | 9 | Environmental Service Systems |
| 5 | Natural Resources Systems | 10 | Other / Undecided ___________ |

4. High school mathematics classes completed:

| | | | | | |
|---|---|---|---|---|---|
| 1 | Algebra I | 2 | Algebra II | 3 | Pre-calculus |
| 4 | Geometry | 5 | Math Models | 6 | AP Calculus |
| 7 | AP Statistics | 8 | Pre-AP Calculus | 9 | Other |

5. Use graphing calculator at school 1 YES 2 NO

6. Frequency 1 Daily 2 Weekly 3 Monthly 4 As required

7. Level of expertise with graphing calculator

   1 Novice 2 Intermediate 3 Competent 4 Expert

8. Own graphing calculator 1 YES 2 NO

9. Brand and model

10. Mathematics grade:

    1 A 2 B 3 C 4 D

11. High school science classes in which you have enrolled:

| | | | |
|---|---|---|---|
| 1 | Principles of Technology | 5 | Chemistry |
| 2 | Biology I | 6 | AP Physics |
| 3 | Physics | 7 | Integrated Physics & Chemistry |
| 4 | Human Anatomy & Physiology | 8 | AP Environmental Science |

12. Estimate of **teams' final placing** _____ out of 30 teams.

13. Estimate of **individual placing** _____ out of 120 individuals

14. Competed in _____ **agricultural mechanics CDEs**

| | | | |
|---|---|---|---|
| 1 | 1 - 3 | 3 | 7 - 9 |
| 2 | 4 - 6 | 4 | 10 or more |

15. Participated in the tractor technician CDE 1 YES 2 NO

16. Ag mech. grade

1 A 2 B 3 C 4 D

17. Overall average GPA

1 A 2 B 3 C 4 D

18. Taken 9th grade Math TAKS 1 NO 2 YES

19. Taken 10th grade Math TAKS 1 NO 2 YES

20. Passed exit-level Math TAKS 1 NO 2 YES

21. Currently enrolled in

1 9th grade 2 10th grade 3 11th grade 4 12th grade

22. Gender 1 Female 2 Male

23. You consider yourself to be:

| | | | |
|---|---|---|---|
| 1 | Native American | 4 | Hispanic American |
| 2 | Asian American | 5 | Caucasian American, not Hispanic origin |
| 3 | African American | 6 | Other |

24. Ever been a member of band, orchestra, or choir?

1 Never a member 2 No longer a member 3 Yes, now a member

25. Member of band, orchestra, or choir at what level?

1 Elementary 2 Middle School 3 High School

# APPENDIX H

## AREA FFA MAP

**Texas Education Agency**
Agricultural Science and Technology
William B. Travis Building
1701 North Congress Avenue
Austin, Texas 78701-1494

Telephone: (512) 463-8984
Fax Number: (512) 463-8057
http://www.tea.state.tx.us/curriculum
http://www.tea.state.tx.us/cte/index.html

State Staff

Mr. Ron Whitson, Program Director
ron.whitson@tea.state.tx.us


**Instructional Materials Service**
Texas A&M University
2588 TAMUS
College Station, Texas 77843-2588
Telephone: (979) 845-6601
Fax Number: ( 979) 845-6608
E-mail: ims@tamu.edu
http://www-ims.tamu.edu/

IMS Staff

Dr. Joe Dettling, Coordinator
Curriculum Specialists:
Mr. Kirk Edney
Mr. Keith W. Zamzow

**AGRICULTURAL EDUCATION AREA MAP**

# APPENDIX I

## TEACHER' S KEY TO STUDENT PROBLEMS

**Evaluating the Mathematics Achievement Levels of Selected Groups of Students Participating in the Texas FFA Agricultural Mechanics CDE**
**Teacher edition**

**Problem 1: Comparing Equipment Rental Costs**

**Course:** **Agriscience 323 – Agricultural Power Technology**

**TEKS:** **323 – c(1)B, c(2)A (state curriculum standard)**

**Math Exit TAKS objective 3** **understanding linear functions, slope & intercept**

There are two tractor rental offers. In the first offer, you must make a $100 down payment and then pay $50 for each month of use. The second offer has a $75 down payment and then $55 dollars for each month of use. After which month is the first offer a better deal?

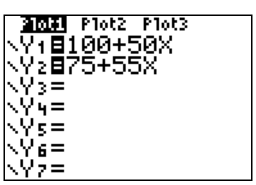
a) 2
b) 3
c) 4
d) 5
e) none of the above

**Solution**

**Overview:** To solve this problem, you will plot the total amount of money both plans will cost and find the intersection of the two curves.

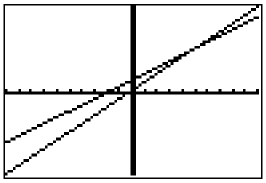
**Step 1:**
Press Y= and clear all equations you might have already entered.

**Step 2:**
Type 100+50X into the $Y_1$= prompt and 75 + 55X into the $Y_2$= prompt. These are the cost equations of the two plans.

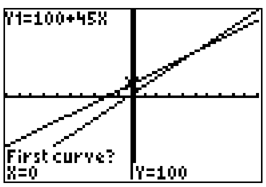



**Step 3:**

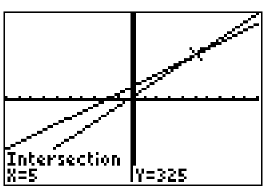
Press ZOOM and then 6 to reset your view to the standard view, then press ZOOM and 0 to have the calculator automatically choose a view to fit the two graphs; this step also plots the two lines on the graph.



**Step 4:**
Press 2nd TRACE to pull up the CALCULATE menu. Choose option 5: intersect and press ENTER. The calculator will display the graph screen and ask you to designate one of the lines as the first curve.  Press ENTER.




**Step 5:**
The calculator now asks for the second curve. Press ENTER again to guess the value of the intersection.  Press ENTER a fourth and final time to calculate the intersection. The screen should show X=5 at the bottom, telling you that the costs of the two plans are identical where the lines intersect at five months. This means that after five months, the first plan will be a better option financially.




**Answer:**_____

# Problem #2: Poultry Nutrition

**Course:** **Agriscience 231 – Plant & Animal Science**
**Agriscience 332 – Animal Science**

**Math Exit TAKS objective 1 Functional relationships**

Different types of poultry feed provide varying levels of energy, measured in megacalories (Mcal), for different prices. The table below shows four available products. What is the most cost efficient (most megacalories per dollar of cost) poultry feed available?

E) Ground wheat
F) Corn
G) Rice bran
H) Grain sorghum

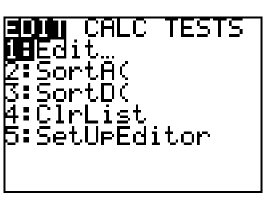
| Feed Type | Energy Value | Cost |
|---|---|---|
| Ground wheat | 152 Mcal/CWT (100 lb) | $14/CWT |
| Corn | 176 Mcal/CWT | $8/CWT |
| Rice bran | 1780 Mcal/ton | $70/ton |
| Grain sorghum | 2040 Mcal/ton | $100/ton |

**Solution**

**Overview:**
To solve this problem, you will calculate the megacalories (Mcal) per dollar of the different feed types.

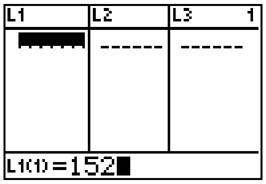
**Preliminary step:**
Press STAT and choose 5:SetUpEditor to ensure that the standard lists ($L_1$->$L_6$) are in the list editor. You only need to do this if you have changed the lists displayed in the editor.

**Step 1:**
Press STAT and select the Edit item from the menu.

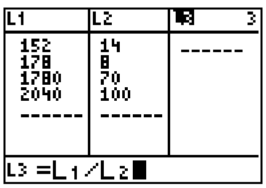


**Step 2:**
Clear any data that might already be in your lists.

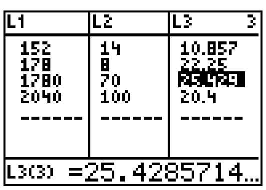
**Step 3:**
In the column under the $L_1$ heading, enter each energy number (presented in megacalories).




**Step 4:**
In the column under the $L_2$ heading, enter the cost of each feed.




**Step 5:**
Using the arrow keys, select the $L_3$ column header as shown in the diagram. Type 2nd 1 / 2nd 2 and press ENTER.




**Step 6:**
The calculator automatically computes list 3 from the energy and price values. The largest number in list 3, corresponding to rice bran, is the most cost effective.

**Answer:**_____

**Problem #3 Calculating Fuel Efficiency**

**Course: Agriscience 323 – Agricultural Power Technology**

**Math Exit TAKS objective 1 Linear functions / understanding of rate**

A survey was conducted to measure fuel consumption, in gallons per hour, of a delivery truck at various speeds. Using the data collected, at which speed, in mph, does the truck consume the least gallons of fuel per mile?

A) 40 mph
B) 50 mph
C) 60 mph
D) 70 mph

| **Speed (MPH)** | **Fuel consumption per hour** |
|---|---|
| 10 | 0.9 |
| 20 | 1.2 |
| 30 | 1.4 |
| 40 | 1.7 |
| 50 | 2.0 |
| 60 | 2.5 |
| 70 | 2.9 |

Answer: <u>B. 50 mph (0.04)</u>

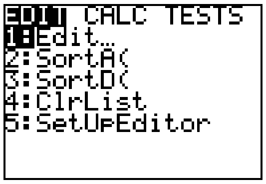
**Solution**

**Overview**

Place the values for speed (miles per hour) in L1 and gasoline consumption (gallons / hour) in L2. L3 = L2/L1. Find the smallest value .04. The number of decimal places is important. The formula is gasoline/hour divided by miles/hour.

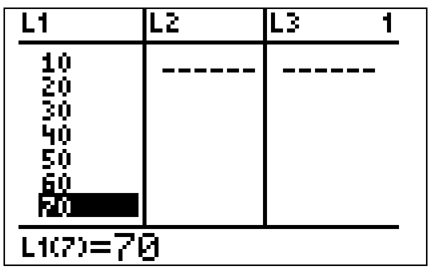
**Preliminary step:**
Press STAT and choose 5:SetUpEditor to ensure that the standard lists ($L_1$->$L_6$) are in the list editor. You only need to do this if you have changed the lists displayed in the editor.

**Step 1:**
Press STAT and select the Edit item from the menu.

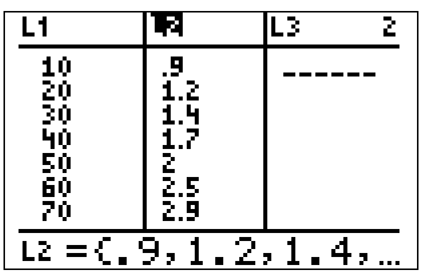



**Step 2:**
Clear any data that might already be in your lists.

**Step 3:**
In the column under the L1 heading, enter each speed value (presented in miles per hour) in L1.




**Step 4:**
In the column under the L2 heading, enter each fuel consumption value (presented in gallons) in L2.




**Step 5:**
Move the cursor to the top of the L3 column. Enter $2^{nd}$ 2 (L2) divided by $2^{nd}$ 1 (L1) and press enter.

| L1 | L2 | L3 3 |
|---|---|---|
| 10 | .9 | .09 |
| 20 | 1.2 | .06 |
| 30 | 1.4 | .04667 |
| 40 | 1.7 | .0425 |
| 50 | 2 | .04 |
| 60 | 2.5 | .04167 |
| 70 | 2.9 | .04143 |

L3(1)=.09

**Step 6:**
The lowest value in column L3 is .04, which corresponds to 50 mph.

**Problem #4** **Growing Replacement Heifers / Hip height**

**Course:** **Agriscience 332 – Animal Science**

**TEKS:** **c(7)B**

**Math Exit TAKS objective 10** **Understanding mathematical tools and processes used in problem solving**

During each month of a heifer's growth, her hip height increases by a certain amount. The hip height of a "Frame Score 7" heifer was recorded monthly for six months. Height measurements were taken on the first day of each month. During which month was the growth the fastest?

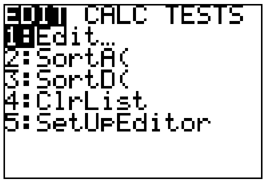
| Age (months) | Hip height (inches) |
|---|---|
| 6 | 46.5 |
| 7 | 47.3 |
| 8 | 48.4 |
| 9 | 49.0 |
| 10 | 49.7 |
| 11 | 50.4 |

E) 6 Months
F) 7 Months
G) 10 Months
H) 11 Months

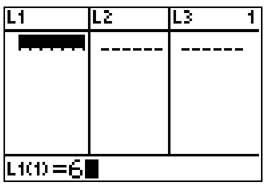
**Answer:**_____

**Solution Overview:**
To solve this problem, each hip height must be subtracted from the next. The calculator has a built-in function for this operation: ∆List().

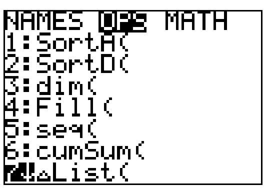
**Step 1:**
Choose STAT>5:SetUpEditor to set up the list editor. Then choose STAT>1:Edit... to display the editor. Clear any data you might already have in the lists by selecting the column header ($L_1$, $L_2$, etc) and pressing CLEAR.

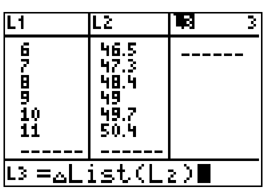



**Step 2:**
Under the column $L_1$ type in 6-11 for the months. Under the column $L_2$ type in the corresponding hip height for each month.

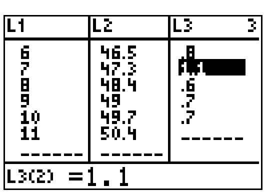



**Step 3:**
Move the cursor to the $L_3$ column. Choose 2nd STAT and cursor to the OPS menu. Scroll down and select item 7, ΔList(. This pastes it into the data the "$L_3$=" entry point. Next, type 2nd 2 to indicate that the data you want is in $L_2$. Close the parentheses, and press ENTER.




**Step 4:**
The data that appears under $L_3$ indicates how much the heifer grew during the month shown in $L_1$. The number selected in the picture, 1.1, is the greatest growth exhibited in the period and occurred in month 7.




**Answer:**_____

## Problem #5: Median Temperature

**Course:** **Agriscience 231 – Plant & Animal Production**
**Agriscience 321 – Agricultural Structures**
**Agriscience 332 – Animal Science**

**TEKS:** **362 – c(4)D; 364 – c(2)C**

**Math Exit TAKS objective 9** **Understanding percents, proportional relationships, probability, and the application of statistics**

Growers want to minimize heating & cooling costs in growing houses, but still must ensure that the birds will tolerate the temperatures of the region. Temperatures are measured at noon for several days and recorded in the table below. What is the median temperature over this period?

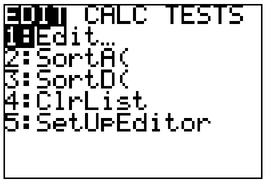
| **Date** | **Daily Temperature** |
|---|---|
| Monday | 75 |
| Thursday | 86 |
| Sunday | 90 |
| Wednesday | 89 |
| Saturday | 85 |
| Tuesday | 82 |

a) 85.5
b) 88.3
c) 85.0
d) 82.7
e) 84.0

**Solution**
**Overview:**
To solve this problem, you will use the calculator's median function.

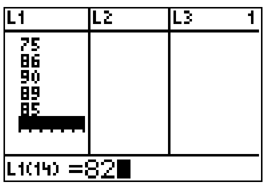
**Preliminary step:**
Press STAT and choose 5:SetUpEditor to ensure that the standard lists ($L_1$->$L_6$) are in the list editor.   You only need to do this if you have changed the lists displayed in the editor.

**Step 1:**
Press STAT and select 1:Edit from the menu.



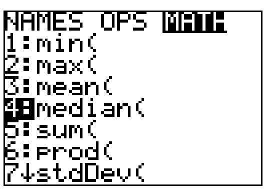

**Step 2:**
Clear any data that might already be in your lists.

**Step 3:**
In the column under the $L_1$ heading, enter each of the temperature readings.

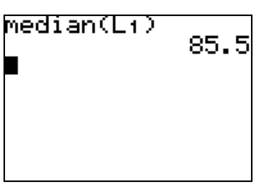



**Step 4:**
Press 2nd MODE to return to the home screen.

**Step 5:**
Press 2nd STAT, scroll right to MATH, then scroll down to 4:median( from the MATH menu. Press ENTER to paste it on the home screen.




**Step 6:**
Press 2nd 1 to enter $L_1$, close the parenthesis, and press ENTER. The calculator displays 85.5, the median of the temperature data you entered.




**Answer:**_____

**Answer Key for Problems**

| Problem Description | Answer |
|---|---|
| 1. Comparing Equipment Rental Costs | D |
| 2. Poultry Nutrition | C |
| 3. Fuel Efficiency | 50 mph |
| 4. Hip Heights | B 7th month |
| 5. Median Temperatures | A |

***Acknowledgements***

*Susan Larson, A+ Math Consulting*
*and*
*Kirk Edney, Instructional Materials Service, Texas A&M University*
*developed, revised, edited, and field-tested this problem set.*

# APPENDIX J

# 2007 STATE AGRICULTURAL MECHANICS CDE

# WRITTEN EXAMINATION

# Texas FFA State Agricultural Mechanics Career Development Event
Host: Sam Houston State University

**Sponsors: Texas Agricultural Mechanics Committee**

## WRITTEN EXAMINATION

Theme for 2007 - **Materials Handling**

**Instructions:** Congratulations on reaching this level of competition. The written exam portion of the Agricultural Mechanics CDE consists of 100 multiple-choice questions, each worth one point.

You have 60 minutes to complete this portion of the CDE. Make sure you are answering the questions in the proper place on the scantron and see that you are marking completely. Please erase clearly and don't tear the scantron sheet. ***PLEASE, DO NOT WRITE ON THE EXAM!*** Thank you. Good luck.

1. The final packaging operation for storing dried forage crops is performed by: (IMS #8792A)
   a. balers
   b. ensilage cutters
   c. forage cutters
   d. planters

2. Which is not a common method for keeping forage material together? (IMS #8792A)
   a. bubble wrap
   b. net wrap
   c. twine wrap
   d. wire wrap

3. Good management practices can limit the loss in round bales stored outside to: (Harrell)
   a. 5 – 10%
   b. 10 – 15%
   c. 15 – 20%
   d. 20 – 25%

4. If hay is too wet when baled, two events generally occur. What are they? (FMO Hay & Forage)
   a. heating & spoiling
   b. natural drying & no spoilage
   c. nothing; baling squeezes out excess moisture
   d. slow cooling & spoilage

5. Hay wrapping around the belt rolls is normally caused by: (FMO Hay & Forage)
   a. excessive travel speed
   b. hay too dry
   c. hay too wet
   d. slow travel speed

6. Operators of round balers may need to use a _____ to thread twine from the storage area to the twine tubes. (FMO Hay & Forage)
   a. fishing line
   b. rope
   c. wire
   d. zip tie

7. Before servicing, cleaning, or _____ a round baler, disengage the PTO, shut off the engine, and remove the ignition key. (FMO Hay & Forage)
   a. adjusting
   b. cooling
   c. operating
   d. painting

8. The most important factor in hydraulic system maintenance is: (FMO Hay & Forage)
   a. brand of hose
   b. cleanliness
   c. viscosity of fluid
   d. weather condition

9. Which device meters appropriate amounts of fuel and air into the small engine? (IMS #8793B)
   a. camshaft
   b. carburetor
   c. crankshaft
   d. governor

10. Oil is mixed with fuel in a two-cycle engine to: (IMS #8793B)
    a. boost horsepower
    b. increase fuel economy
    c. keep water out of fuel
    d. lubricate the engine

11. To get correct torque values when tightening bolts, _____. (IMS #8414)
    a. clean external & internal threads
    b. clean external threads
    c. clean internal threads
    d. clean threads are not essential for proper torque.

12. Which is not a part of a spark plug? (IMS #8793B)
    a. cap
    b. ceramic insulator
    c. ground electrode
    d. steel gasket

13. Change engine oil when the engine is at _____ temperature.
    (IMS #8793B)
    a. atmospheric
    b. low
    c. operating
    d. room

14. Safety signal words like “danger,” warning,” and “duck” are located near _____.
    (IMS #8790)
    a. criteria
    b. events
    c. hazards
    d. individuals

15. The four basic events in a four-stroke cycle engine are completed in _____ strokes of the piston in the cylinder. (IMS #8793A)
    a. 2
    b. 3
    c. 4
    d. 6

16. The strongest safety signal word is _____. (IMS #8790)
    a. be careful
    b. caution
    c. danger
    d. watch out!

17. To increase tractor stability, set rear wheels to the _____ width.
    (IMS #8790)
    a. maximum
    b. minimum

18 .Which SAE grade of standard steel bolts has the highest tensile strength?
    (IMS #8414)
    a. Grade 0 (zero)
    b. Grade #1
    c. Grade 5XP
    d. Grade 8

19. When operating a farm tractor along a public road, the operator must: (IMS #8790)
    a. use required warning devices
    b. use a properly-mounted SMV emblem
    c. use warning lights
    d. all of the above

20. IF you are baling hay in a field that is 1056 feet long, and can travel from one end to the other in
    2.4 minutes, your speed is: (IMS #8792E)
    a. 0.5 mph
    b. 0.65 mph
    c. 5.0 mph
    d. 6.5 mph

21. The term “permanent antifreeze” means that: (Harrell)
    a. the antifreeze will not boil away under normal operating conditions
    b. freezing is permanently prevented
    c. the antifreeze will not need replacing
    d. the system can’t boil over.

22. There are _____ square feet in an acre. (IMS #8792E)
    a. 640
    b. 5280
    c. 16400
    d. 43560

23. Lubricating oil creates a seal between the rings and the piston, and between the rings and the cylinder wall, increasing: (IMS #8793A)
    a. combustion
    b. compression
    c. exhaust
    d. oil consumption

24. The top ring on a piston is called the: (IMS #8793A)
    a. centering ring
    b. compression ring
    c. keystone ring
    d. oil ring

25. The first step in operating a round baler is to:
    a. make sure the lights work properly
    b. make sure no one is behind the baler
    c. read the operator’s manual
    d. start the machine to get the ”feel” of it

26. Used engine oil or transmission fluid should be discarded by: (IMS #8794C)
    a. burning
    b. pouring down a drain
    c. poring on a sand or dirt driveway
    d. recycling

27. Drive chains should be well-lubricated with a spray-type lubricant and checked: (Harrell)
    a. at the beginning of the hay season
    b. upon completion of baling
    c. every 2 – 4 hours of use
    d. once daily

28. A drive sprocket with hooked teeth indicates that: (FOS Belts & Chains)
    a. the sprocket should be used with single-pitch chains
    b. the sprocket should be used with pintle or H-type chains
    c. the sprocket should be used with double-pitch roller chains
    d. the sprocket is worn and should be replaced

29. The fluidity of engine oil is referred to as: (IMS #8794C)
    a. liquidity
    b. opacity
    c. turbidity
    d. viscosity

30. The rate of machine performance in terms of land area per time unit is called: (IMS #8792A)
    a. field capacity
    b. horsepower
    c. speed
    d. torque

31. Most engine coolants contain: (FOS Fuels & Coolants)
    a. alcohol
    b. ethylene glycol
    c. methanol
    d. propanol

32. The bottom ring on the piston is called the: (IMS #8793A)
    a. centering ring
    b. compression ring
    c. keystone ring
    d. oil ring

33. A tractor's ROPS is designed to: (IMS #8790)
    a. be sold as optional-only equipment
    b. prevent overturns
    c. protect a seat-belted operator from being crushed in an overturn
    d. provide air conditioning for tractor cabs

34. A piston's greatest distance from the center line of the crankshaft is at:
    a. bottom dead center
    b. top dead center
    c. neither answer
    d. both answers

35. Never tow a round baler faster than _____. (IMS #8790)
    a. 15 mph
    b. 20 mph
    c. 40 mph
    d. 55 mph

36. Before operating a round baler, be sure to _____. (IMS #8790)
    a. have all safety shields & covers in place when the machine is running
    b. have someone stand behind the baler to observe ejecting the first five bales
    c. remove decals and safety shields
    d. unhook the PTO safety chain

37. The best source of information regarding safe operation of agricultural machinery is the:
    a. agricultural science teacher
    b. county extension agent
    c. farm machinery magazine
    d. owner's manual

38. The standard compression ratio for small gasoline engines is: (IMS #8793A)
    a. 8:1
    b. 11.5:1
    c. 16:1
    d. 22:1

39. Small gas engines are widely accepted for all of the following reasons except: (IMS #8793B)
    a. cooled by surrounding air
    b. light in weight
    c. require excessive maintenance
    d. small in size

40. The safety signal word that identifies general safety information and instructions is:(IMS #8790)
    a. Caution!
    b. Danger!
    c. Warning!
    d. Watch out!

41. In the API engine oil classification system, the second letter in the grade indicates:
    a. the engine model year that the oil is recommended for use
    b. the oil is to be used in spark ignition systems
    c. the viscosity of the engine oil
    d. the weight of the oil

42. The formula for calculating horsepower is w (lbs) X D (ft) X T (sec) divided by:
    a. 5
    b. 50
    c. 500
    d. 550

43. The correct stroke sequence in a 4-cycle Briggs & Stratton engine is: (IMS #8793A)
    a. compression, intake, power, exhaust
    b. intake, compression, power, exhaust
    c. intake, power, compression, exhaust
    d. power, exhaust, compression, intake

44. Which is NOT one of the three areas of guard maintenance? (FOS Mowers)
    a. checking guard condition
    b. checking knife sections
    c. adjusting or replacing guards
    d. adjusting the guard-to-lip clearance

45. You stand to inherit an older baler, valued at $3,000, which needs some work. You will spend about $375 in repair costs, and estimate that it will cost about $115 per hay season in maintenance. You also estimate it costs you about $5 per bale to roll your own hay. How many bales must you put up in three years to cover the cost of the baler, and all repair and maintenance costs? (FBM Machinery Mgmt)
    a. 144
    b. 444
    c. 744
    d. 1044

46. On a Model 92902 Briggs & Stratton engine, the first 9 indicates: (B&S Repair Manual)
    a. arrangement of crankshaft
    b. cubic inch displacement (CID) of engine
    c. flywheel diameter
    d. type of starter

47. To remove the flywheel starter clutch on a Briggs & Stratton flywheel, use: (IMS #8793C)
    a. an air impact wrench & deep socket
    b. a flat pry bar & adjustable wrench
    c. a flywheel holder tool #19167 & starter clutch wrench #19244
    d. a torque wrench & spanner wrench

48. _____ bolts resemble a steel rod threaded on both ends. (IMS #8414)
    a. Carriage
    b. Machine
    c. Stove
    d. Stud

49. A baler towed at 470 fpm is traveling ___ MPH. (IMS #8792E)
    a. 3.3
    b. 4.3
    c. 5.3
    d. 6.3

50. API oil service classifications for spark-ignition engines use the letter(s): (IMS #8794C)
    a. C
    b. CAE
    c. S
    d. SAE

51. What is the displacement of a small engine with a 4” stroke and a 4” bore? (IMS #8203A)
    a. 8.377
    b. 16.00
    c. 50.26
    d. 60.17

52. Using the formula MPH = [distance (ft) / time (sec)] / 1.466, a baler that travels 125 feet in 27 seconds is: (IMS #8792A)
    a. 2.76
    b. 2.91
    c. 3.00
    d. 3.15

53. Two-cycle engines do NOT have: (IMS #8793B)
    a. carburetors
    b. fuel tanks
    c. oil sumps
    d. wheels

54. You are interested in purchasing a used 2003 JD 567 round baler. The asking price is $21,100 and 6% simple interest with dealer financing. If you take 7 years to pay for the baler, how much is the annual payment?
    a. $3000
    b. $3195
    c. $3380
    d. $3500

55. If a round baler does not pick up hay cleanly, the problem might be: (FMO Hay & Forage)
    a. bent / broken pickup teeth
    b. ground speed too slow
    c. pickup teeth set too high
    d. either **b** or **c**.

56. Properly serviced air cleaners remove _____ % or more of the dirt and other solid particles in the air.
    a. 85
    b. 90
    c. 95
    d. 99

57. The engine should be at _____ temperature when changing engine oil. (Harrell)
    a. atmosphere
    b. low
    c. operating
    d. room

58. Use a belt lacer to _____: (FMO Hay & Forage)
    a. adjust belt tension
    b. cut belts
    c. repair broken belts
    d. route belts thru bale chamber

59. Self-tapping screws are available with both pointed and _____ ends. (IMS #8414)
    a. blunt
    b. pilot
    c. plain
    d. TEK

60. When the automatic choke is operating properly on a Briggs & Stratton engine:
    a. the choke plate will alternately open and close
    b. the engine starts with the first pull of the starter rope
    c. the engine will have poor fuel economy at idle speed
    d. the engine will hunt at idle speed

61. There are _____ linear feet in one mile.
    a. 5082
    b. 5280
    c. 5333
    d. 5820

62. Rotary mowers have _____. (FOS Mowers & Sprayers)
    a. pivoting knives
    b. one or more rotating blades
    c. reciprocating knives
    d. disk type knives

63. The most common method of preventing crankshaft damage in small air-cooled engines is:
    a. adjustable wheels
    b. flywheel key
    c. magneto shaft
    d. PTO shaft

64. The approximate speed in MPH of a round baler covering 600 ft in 54 seconds is: (IMS #8221)
    a. 4.876
    b. 5.778
    c. 6.875
    d. 7.578

65. A PTO shaft rated for 540 RPM has _____ splines. (Harrell)
    a. 6
    b. 7
    c. 8
    d. 10

66. A hay field that covers 630,620 square feet contains _____ acres.
    a. 13.8
    b. 14.5
    c. 119.5
    d. 143.8

67. You wish to purchase a used New Holland 688 baler. The asking price is $7000, at 6% simple interest with dealer financing. IF you pay off the baler in 3 years, about how much is the annual payment?
    a. $2300
    b. $2475
    c. $2650
    d. $2850

68. A baler that covers 300 ft in 60 seconds is moving at a rate of _____. (IMS #8792)
    a. 0.2
    b. 1.8
    c. 3.4
    d. 5.0

69. A spinner-type PTO shield on a round baler: (Harrell)
    a. allows the operator to change shaft speed & direction while in operation
    b. eliminates all danger from PTO shafts
    c. only functions properly under 600 RPM
    d. stops when touched, but allows the PTO shaft to continue rotation

70. When excessive wear is diagnosed in the aluminum valve guides of a B & S engine, the guides should be: (B & S Repair Manual)
    a. coated with JB weld
    b. knurled
    c. reconditioned with a bushing
    d. replaced

71. The small engine carburetor vaporizes fuel in order to: (IMS #8793B)
    a. eliminate any water vapor trapped in the fuel
    b. help each fuel molecule contact enough oxygen to burn completely
    c. increase the fuel-to-air ratio
    d. increase the heat contact prior to ignition

72. The ideal field shape for baling hay is: (IMS #8221A)
    a. irregular
    b. long & narrow
    c. oval
    d. square

73. Classify small gas engines by the orientation of the: _____. (IMS #8793B)
    a. crankshaft
    b. cylinders
    c. nameplate
    d. oil pan

74. Use a _____ fire extinguisher on oil-based fires on small gasoline engines. (IMS #8790)
    a. Type A
    b. Type B
    c. Type C
    d. Type D

75. One horsepower is the amount of force needed to: (IPC)
    a. lift 550 lbs. one foot in one second
    b. lift 33,000 lbs. one foot in one minute
    c. both **a** & **b**
    d. neither **a** nor **b**

76. A Type II PTO shaft rotates at _____. (IMS #8204A)
    a. 540
    b. 650
    c. 880
    d. 1000

77. Troubleshoot a small gas engine with low compression by: (IMS #8793B)
    a. checking the ignition system
    b. checking to see if the flywheel is properly mounted
    c. checking to see if the spark plug is loose
    d. checking to see if an oil additive is needed.

78. You are a custom operator, and are considering the purchase of a used Hew Holland 688 baler for $11,500. If you charge $15 per bale, and allow for a salvage value of $3000, how many bales must you roll annually to pay off the baler in three years?
    a. 150
    b. 166
    c. 188
    d. 566

79. According to the Briggs & Stratton repair manual, the air filter pre-cleaner of a small engine should be cleaned at least every _____ hours.
    a. 10
    b. 15
    c. 20
    d. 25

80. Round balers are calibrated to record: (IMS #8792E)
    a. acres per hour
    b. hours of operation
    c. hours per week
    d. number of bales

81. Advantages of _____ fasteners include design flexibility, corrosion resistance, and weight.
    a. aluminum
    b. brass
    c. mild steel
    d. plastic

82. Wear in the cylinder bore of a small engine is called: (Harrell)
    a. distortion
    b. out-of-round
    c. scoring
    d. taper

83. At normal operating temperature, the temperature of the engine lubrication system generally ranges: (IMS #8794C)
    a. 150 – 175 degrees F
    b. 175 – 200 degrees F
    c. 200 – 225 degrees F
    d. 225 – 250 degrees F

84. One gallon is equal to _____ fluid ounces. (IMS #4320)
    a. 32
    b. 68
    c. 128
    d. 230

85. Hydrocarbons in lubricating oil combine with oxygen in the air to produce organic acids in a process called: (FOS Engines)
    a. bypass insurgency
    b. carbonization
    c. corrosion
    d. oxidation

86. To make bolts and screws complete metal-to-metal fasteners, use _____. (IMS #8414)
    a. nuts
    b. rivets
    c. threads
    d. washers

87. Before round baling, hay on the ground should be checked for a moisture content of: (Harrell)
    a. 5 – 10%
    b. 10 – 15%
    c. 15 – 20%
    d. 20 – 25%

88. Moving the right arm across the neck in a "throat-cutting" motion is the ASABE hand signal for:
    a. open the bale chamber this high
    b. start the tractor engine
    c. stop forward travel
    d. stop the tractor engine

89. The lowest temperature at which lubricating oil will flow is the: (IMS #8794C)
    a. cloud point
    b. dispersant point
    c. pour point
    d. viscosity point

90. The Society of Automotive Engineers (SAE) specifies the: (IMS #8794C)
    a. classification of engine oils
    b. combustion range of hydrocarbons
    c. detergent index of engine oils
    d. viscosity ranges of engine oils & gear lubricants

91. A section of land contains: (IMS #8772)
    a. 160 acres
    b. 640 acres
    c. 1000 acres
    d. 5280 acres

92. A valuable tool for measuring both the size and slope of a hayfield is the: (IMS #8772)
    a. land place
    b. shovel
    c. slope potentiometer
    d. tripod level

93. When preparing a tractor to operate a round baler, you should: (FMO Hay & Forage)
    a. adjust front wheel spacing
    b. adjust front and rear wheel spacing
    c. adjust rear wheel spacing
    d. none of the above.

94. Which operations of a round baler can be adjusted? (FMO Hay & Forage)
    a. bale density
    b. bale size
    c. pickup height
    d. all of the above

95. A round bale with uniform density is more likely to: (FMO Hay & Forage)
    a. collapse during storage
    b. retain its shape
    c. spoil
    d. all of the above

96. Measuring the piston ring end gap will indicate: (IMS #8793C)
    a. amount of wear on rings and/or cylinder wall
    b. clearance between piston and cylinder wall
    c. clearance volume of the engine
    d. number of hours in service

97. The lubricating characteristics of engine oil serve to reduce: (IMS #8794C)
    a. condensation
    b. contamination
    c. emissions
    d. friction

98. A partially sheared flywheel key in a small gas engine will: (Briggs & Stratton repair manual)
    a. change ignition timing
    b. change the carburetor air-fuel mixture
    c. change the oil pressure
    d. change the valve timing

99. Adjust the chains on a round baler by: (FMO Hay & Forage)
    a. adding links
    b. moving the idler pulley
    c. removing links
    d. all of the above

100. An advantage of using net wrap in a round baler is: (FMO Hay & Forage)
    a. improves field efficiency
    b. improves quality
    c. reduces waste
    d. all of the above

# APPENDIX K

# 2008 STATE AGRICULTURAL MECHANICS CDE

# WRITTEN EXAMINATION

# Texas FFA State Agricultural Mechanics Career Development Event

Host: Sam Houston State University

**Sponsors: Texas Agricultural Mechanics Committee**

## WRITTEN EXAMINATION

Theme for 2008 – **Poultry Processing**

**Instructions:** Congratulations on reaching the state level of competition. The written exam of the Agricultural Mechanics CDE consists of 100 multiple-choice questions, each worth one point.

You have 60 minutes to complete this portion of the CDE. Make sure you are answering the questions in the proper place on the scantron and see that you are marking completely. Please erase clearly and don't tear the scantron sheet. ***PLEASE, DO NOT WRITE ON THE EXAM!*** Thank you. Good luck.

1. Broiler litter accumulates at a rate of approximately 0.0013 cubic feet per bird per day. If you feed 4,000 birds, how many cubic feet of litter will accumulate in one year?
   a. 5.2 $ft^3$
   b. 1,898 $ft^3$
   c. 3,500 $ft^3$
   d. 35,000 $ft^3$
2. Many manufacturers recommend that hydraulic oil be drained and new oil added after _____ hours of operation.
   a. each 25
   b. 50 – 100
   c. 100 – 150
   d. after 200
3. Foamy hydraulic oil and jerky or noisy operation is an indication that:
   a. there is air in the system
   b. the fluid has dirt in it
   c. the hydraulic pump is worn out
   d. the reservoir is low on fluid.
4. A broiler house with an area of 22,000 square feet covers _____ acres.
   a. 0.505
   b. 1.98
   c. 2.444
   d. 4.166
5. The accumulator in a hydraulic system stores:
   a. air
   b. energy
   c. fuel
   d. water

6. A lever action which produces, or tends to produce, rotation is known as _____.
   a. lift
   b. power
   c. strength
   d. torque
7. A broiler house with an area of 22,000 square feet, containing a depth of two feet of broiler litter, holds _____ cubic yards of litter.
   a. 1629
   b. 4888
   c. 11,110
   d. 14,667
8. A _____ valve allows fluid to pass freely into a cylinder as fluid pushes a ball off its seat. When flow stops, a spring pushes the ball onto the seat, trapping fluid in the cylinder.
   a. check valve
   b. flow valve
   c. gauge valve
   d. manual valve
9. _____ law states that when pressure is developed on a fluid, the fluid acts equally in all direction, regardless of the shape of the container.
   a. Newton's
   b. Murphy's
   c. Pascal's
   d. Priddy's
10. Pressure multiplied by area of piston equals the _____.
    a. length of the stroke
    b. load-carrying capacity
    c. pounds per square inch (psi)
    d. revolutions per minute (rpm)
11. You plan to pour a concrete apron at the entrance of your broiler house to decrease tire ruts. This slab will be 4" thick X 14' wide X 42' long. How many cubic yards of concrete should you order?
    a. 2.5
    b. 4.15
    c. 7.25
    d. 27.00
12. There are _____ in one acre.
    a. 4400 square yards
    b. 5280 square feet
    c. 43560 square feet
    d. 45360 square yards
13. A metal or wooden structure that confines concrete to a particular shape until it hardens is a _____.
    a. brace
    b. footing
    c. form
    d. stud

14. The drying process that strengthens concrete and lasts for several days is called _____.
    a. conditioning
    b. curing
    c. hardening
    d. settling
15. A tractor and front-end loader that travels 300' feet in one minute is moving at:
    a. 1.8 mph
    b. 3.4 mph
    c. 5.0 mph
    d. insufficient information to determine answer
16. A _____ is an area designed for a planned break which permits concrete to expand and contract without visibly cracking.
    a. construction joint
    b. contraction joint
    c. control joint
    d. freeze joint
17. You are interested in purchasing a used JD 48 front-end loader attachment for your poultry operation. The loader is offered for $2900 and 6% simple interest with dealer financing. If you pay for the loader in three years, how much is the annual payment?
    a. 522.80
    b. 966.67
    c. 1024.67
    d. 1140.67
18. This mathematical equation $a^2 + b^2 = c^2$ is called the:
    a. Area formula
    b. Volume formula
    c. Pascal's theorem
    d. Pythagorean theorem
19. Skin protection is critical while working with concrete because:
    a. materials are abrasive to bare skin
    b. wet concrete is very alkaline & caustic to skin; it has a pH of 12 -13
    c. wet concrete is hygroscopic, and draws moisture from the skin
    d. all of the above
20. Safety-alert symbols and signal words are used on front-end loaders to identify unsafe situations. Which signal word identifies the most potentially hazardous situation?
    a. Caution!
    b. Danger!
    c. Warning!
    d. Watch out!

21. Before your loan will be funded, your loan officer wants to know the median temperature for your county in August. You record the 5:00 pm temperature for several days, and get the readings shown in the table below.

| **Day of the Week** | **Temperature @ 5:00 PM** |
|---|---|
| Sunday | 102 |
| Wednesday | 96 |
| Saturday | 105 |
| Tuesday | 101 |
| Friday | 103 |

Your median temperature in August is approximately:
a. 98
b. 101.4
c. 102
d. 105

22. The boom lift cylinder on a front-end loader probably has _____ seals.
a. compression
b. diaphragm
c. o-ring & back-up
d. radial lip

23. Calculate _____ by multiplying force X distance (length of lever arm).
a. energy
b. force
c. torque
d. work

24. A _____ vale is designed into most hydraulic systems to prevent damage due to excessive pressure.
a. directional control
b. flow control
c. lift control
d. relief

25. A fundamental physical law of hydraulics is that liquids:
a. can be neither created nor destroyed
b. cannot be compressed
c. do not transmit force as efficiently as gases
d. reduces in volume proportional to the pressure applied.

26. The ground speed of a tractor & front-end loader that travels 125 feet in 27 seconds is:
a. 2.76 mph
b. 2.91 mph
c. 3.00 mph
d. 3.15 mph

27. When operating a front-end loader, the center of gravity:
a. lowers because the weight of the load anchors the tractor to the ground
b. rises as the load lowers
c. rises as the load rises
d. stays constant regardless of the height and weight of the load

28. The formula for calculating horsepower is W (lbs.) X D (ft.) X T (sec.) divided by _____.
    a. 10
    b. 50
    c. 500
    d. 550
29. A hydraulic system that operates with the tractor engine running, and causes the fluid to flow from a reservoir, through a control valve, and back to the reservoir when the control lever is in the neutral position is a _____ system.
    a. closed-center
    b. hydrostatic
    c. open-center
    d. remote sensing
30. The load capacity of a hydraulic cylinder is equal to:
    a. length of ram
    b. pressure X area of piston
    c. pressure X radius of cylinder
    d. weight of object to be lifted
31. Diagonal measurements taken at the corner stakes of a foundation ensure that _____.
    a. the structure is level
    b. the structure is plumb
    c. the structure is of the proper height.
    d. the structure has square corners
32. One sack of Portland cement contains _____.
    a. ½ cubic foot
    b. 1 cubic foot
    c. 9 cubic feet
    d. 1 cubic yard
33. Striking the excess concrete off the forms is called _____.
    a. floating
    b. jitterbugging
    c. screeding
    d. troweling
34. On construction that must be disassembled later, such as forms or scaffolding, use _____ nails.
    a. box
    b. casing
    c. concrete
    d. duplex
35. You plan to spread broiler litter on a field that is 630,600 $ft^2$, or _____ acres, in size.
    a. 14.5
    b. 65.5
    c. 120.0
    d. 146.45

36. Ready-mixed concrete is sold by the _____.
    a. cubic foot
    b. cubic yard
    c. square foot
    d. square yard
37. Treat forms with _____ to prevent sticking to the cured concrete.
    a. enamel paint
    b. lime
    c. a releasing agent
    d. wax
38. One cubic yard of concrete contains _____ cubic feet.
    a. 3
    b. 9
    c. 18
    d. 27
39. Use a _____ test to determine the workability, or plasticity, of a batch of fresh concrete.
    a. percent entrained air
    b. slump
    c. volume of coarse aggregate
    d. yield estimate
40. The chemical reaction that occurs between water molecules and cement during hardening is called:
    a. compounding
    b. fixation
    c. hydration
    d. screeding
41. The floor of a poultry facility that measures 30 feet X 48 feet X 6" contains _____ cubic yards of concrete.
    a. 22.22
    b. 27
    c. 600
    d. 720
42. One mile per hour is the equivalent of _____ feet per minute.
    a. 88
    b. 640
    c. 1620
    d. 5280

43 The safest way to check for high-pressure hydraulic leaks is to use:
    a. a piece of paper or cardboard
    b. the back of your hand
    c. soapy water solution
    d. commercial leak detector solutions

44. Hydraulic pumps are rated by:
    a. energy produced per second & leak down rate
    b. flow in ounces per minute (OPM) / liters per minute (LPS) at a designated rate & capacity
    c. flow in gallons per minute (GPM) / liters per minute (LPM) at a designated speed and pressure
    d. pressure of valves pumping gallons per minute.
45. Using two wrenches to tighten hydraulic fittings prevents:
    a. dirty hands
    b. excessive line pressure
    c. carpal tunnel strain on one hand
    d. twisted lines
46. The roof of a resting shed for broiler trucks is forty squares. What does this mean?
    a. the roof is 40' X 40' square
    b. the roof can be covered with 40 sheets of plywood
    c. the roof is 400 square feet
    d. the roof is 4,000 square feet.
47. Portland cement is manufactured from lime, iron oxide, silica, and alumina mixed in proper proportions and heated in a kiln to about
    a. 300 degrees F
    b. 3000 degrees F
    c. 30,000 degrees F
    d. 300,000 degrees F
48. Concrete cured for 7 days has _____ the strength of concrete cured for 28 days.
    a. 1/3
    b. 2/3
    c. 3/4
    d. 7/8
49. The concept of mixing 42 volumes of cement and aggregates to produce 27 volumes of concrete is called:
    a. Aspdin's Rule
    b. Fuller's Rule
    c. Golden Rule
    d. Portland Rule
50. The metric unit of pressure measurement is:
    a. lbs.
    b. $(N/m^2)$
    c. pounds
    d. psi
51. The formula for determining ground speed of a tractor with a front-end loader is:
    a. $\text{MPH} = \dfrac{\text{distance traveled (ft) / travel time in hours}}{1.466}$
    b. $\text{MPH} = \dfrac{\text{miles per hour / travel time in seconds}}{1.466}$
    c. $\text{MPH} = \dfrac{\text{distance traveled (ft) / travel time (sec)}}{1.466}$
    d. none of the above

52. The measurement used to determine degree of filtration / filter size is the:
    a. beta
    b. micron
    c. millisecond
    d. none of the above
53. Most better-quality greases contain _____ to improve product performance.
    a. calcium
    b. lithium
    c. molybdenum
    d. paraffin
54. Placing your head, arms, and/or upper body through the boom arms or lift cylinders and frame of a front-end loader creates a _____ hazard.
    a. pinch point
    b. pull-in point
    c. shear point
    d. wrap point
55. If you are moving round bales the length of a 1056' long field in 2.4 minutes, your ground speed is:
    a. 0.5 mph
    b. 0.65 mph
    c. 5.0 mph
    d. 6.5 mph
56. A double-acting cylinder:
    a. exerts force in two directions of travel
    b. exerts twice as much force as a single-acting cylinder
    c. operates twice as fast as a single-acting cylinder
    d. has twice the longevity of a single-acting cylinder.
57. All of the following are types of hydraulic pumps except:
    a. gear
    b. piston
    c. ratchet
    d. vane
58. Hydraulic motors are considered _____ displacement motors.
    a. fluid
    b. negative
    c. neutral
    d. positive
59. When all ingredients are properly combined, the approximate weight of a cubic foot of concrete is:
    a. 50 – 60
    b. 80 – 90
    c. 150 – 160
    d. 180 – 190

60. Concrete reinforcing bars should be lapped at intersections to increase the foundation strength. The minimum distance for lapping ½” rebar is 24 diameters, or:
    a. 6”
    b. 12”
    c. 18”
    d. 48”
61. The _____ strength of concrete is significantly less than the compressive strength.
    a. shear
    b. slip
    c. tensile
    d. torque
62. A sack of Portland cement weighs _____ pounds.
    a. 74
    b. 84
    c. 94
    d. 100
63. The preferred concrete admixture for protection against freezing and thawing is:
    a. accelerating
    b. air-entraining
    c. a pozzolan
    d. retarding
64. Powering machinery through the use of fluids is called:
    a. Hydraulics
    b. Hydrostatics
    c. Pneumatics
    d. Systolics
65. The ground speed of a tractor and front-end loader that travel 135 feet in 17 seconds is:
    a. 5.006 mph
    b. 5.155 mph
    c. 5.416 mph
    d. 5.765 mph
66. The process for manufacturing Portland cement was developed by _____.
    a. Joseph Arguello
    b. Joseph Ashley
    c. Joseph Aspdin
    d. Joseph Austin
67. Use a _____ admixture to control expansion when placing concrete in hot weather.
    a. accelerating
    b. air-entraining
    c. pozzolan
    d. retarding

68. Use a _____ admixture to control setting time when placing concrete in hot weather.
    a. accelerating
    b. air-entraining
    c. pozzolan
    d. retarding
69. Hydraulic systems can be classified by the type of control valve.
    a. false
    b. true
70. You have designed a broiler house that measures 300’ X 40’ X 10’. The volume of this house is _____ cubic feet.
    a. 1200
    b. 12000
    c. 3660
    d. 120000
71. You are purchasing fans that move 1800 cubic feet per minute (cfm). This type of fan will move _____ cubic feet of air in one hour.
    a. 1800
    b. 5400
    c. 54000
    d. 108000
72. You have contracted to grow large broilers for Samhouston Farms. Your agreement specifies a minimum of five air changes per hour in a growing facility similar to the broiler house in #70. You need to install ____ fans similar to the one used in #71.
    a. 4
    b. 5
    c. 6
    d. 7
73 Advantages of closed-center hydraulic systems include:
    a. relief vales are not required
    b. lines, valves & cylinders can be tailored to flow requirement
    c. reserve flow capacity ensures full hydraulic speed at low engine rpm
    d. holding the valve open applies standby pressure to piston constantly
    e. all of the above.
74. Use a _____ to remove any ridges in fresh concrete caused by screeding.
    a. broom
    b. bull float
    c. edger
    d. trowel
75. A 326,570 $ft^2$ field provides _____ acres for spreading broiler litter.
    a. 7.49
    b. 14.59
    c. 27.30
    d. 61.85

76. When torquing bolts on front-end loaders, it is sometimes necessary to convert foot-pounds to inch-pounds. Sixteen foot-pounds is equal to _____ inch-pounds.
    a. 1.5
    b. 85
    c. 192
    d. 256
77. The type of hydraulic system that maintains fluid at full pressure is the _____ system.
    a. closed-center
    b. hydrostatic
    c. open-center
    d. remote sensing
78. What is the cubic inch displacement (volume) of a hydraulic cylinder with a 4" stroke and a 4" bore?
    a. 8.377
    b. 16.00
    c. 50.26
    d. 60.17
79. The hydraulic system component that moves fluid to the cylinder is the:
    a. pump
    b. ram
    c. reservoir
    d. valve
80. Proper jointing encourages concrete slabs to crack:
    a. on the corners of the slab
    b. on the underside of the slab
    c. in predictable areas
    d. in predictable, straight lines
81. One purpose of bull floating a concrete slab is to:
    a. move water to the surface to speed up curing
    b. move water to the surface to wet cure the concrete
    c. leave a coarse finish on the floor surface
    d. level the surface and imbed the coarse aggregate below the surface
82. Control joints in concrete slabs should be about _____ of the slab's thickness.
    a. 1/8th
    b. 1/4th
    c. 1/3rd
    d. 1/2
83 In a 5" – 6" thick slab, reinforcement should be placed about _____ below the surface.
    a. 1/2 the slab's thickness
    b. 2/3 the slab's thickness
    c. 1"
    d. 2"

84. A concrete slab that is 8” thick is _____ as strong as a 4” thick slab.
    a. 2X
    b. 3X
    c. 4X
    d. 5X
85. Service recommendations specify 84 inch-pounds of torque on the bolts holding the hydraulic lines in place on your front-end loader. Your torque wrench only read in foot-pounds. Which setting should you use?
    a. 7.0 ft-lbs
    b. 8.4 ft-lbs
    c. 10.8 ft-lbs
    d. none of the above
86. During transport, keep the arms on a front-end loader in a _____ position.
    a. any
    b. high
    c. low
    d. mid-level
87. If the front-end loader “chatters” while the arms are raised, the cause might be:
    a. fluid filter is clogged
    b. fluid is too heavy
    c. pump is worn
    d. any of the above
88. One disadvantage of a hydraulic system is:
    a. flexibility
    b. need for cleanliness
    c. safety
    d. simplicity
89. The process of removing air from a hydraulic system is called:
    a. abrading
    b. bleeding
    c. drifting
    d. flowing
90 A hydraulic system normally operates at _____ pressure.
    a. full-flow
    b. operating
    c. system
    d. working
91. You and a friend are starting a broiler house cleaning business, and are considering leasing, rather than buying, a couple of tractors. One tractor can be leased for $150 down, and $75 per month. Another implement dealer offers a lease option at $100 down and $90 per month. After which month is the first offer more economical?
    a. 2
    b. 3
    c. 4
    d. 5

92. By law, all agricultural equipment transported on a public highway should be identified by a _____ emblem.
    a. CSE – Caution! Slow Equipment
    b. FEM – Farm equipment on the Move
    c. SMV – Slow Moving Vehicle
    d. None of the above
93. The struck capacity of a front-end loader's bucket is _____ the heap capacity.
    a. equal to
    b. greater than
    c. less than
    d. unrelated to
    Generic front-end loader operator's manual
94. When placing liquid ballast in tractor tires, add _____.
    a. any lighter-than-water chemical
    b. calcium chloride
    c. degreaser, any brand
    d. diesel fuel
95. To determine local suitability for broiler production, you want to identify the median temperature of your region. After taking several readings over a period of days, you get the temperature values shown in the table. What is the median temperature?

| Date | Daily high temperature |
|---|---|
| Tuesday | 85 |
| Friday | 91 |
| Monday | 95 |
| Thursday | 94 |
| Sunday | 98 |
| Wednesday | 90 |
| Monday | 92 |

    a. 92
    b. 92.2
    c. 94
    d. 96
96. Cavitation wear or damage in a hydraulic system can be caused by:
    a. air in the system
    b. excess hydraulic fluid
    c. faulty pump
    d. insufficient fluid
97. Objects in motion tend to remain in motion unless another force is exerted upon the object. The force that resists a change in direction is called _____ force.
    a. centrifugal force
    b. centripetal force
    c. horsepower
    d. torque

98. The foundation of a poultry growing facility probably has a _____ foundation.
    a. basement
    b. crawl space
    c. pile
    d. slab on grade
99. Control joints in concrete slabs should be placed _____ as far apart in feet as the slab thickness in inches.
    a. five times
    b. four times
    c. three times
    d. twice
100. Broiler litter, without added bedding, accumulates at the rate of 0.0013 cubic feet per bird per day. Approximately how many cubic feet of litter accumulate in 30 days if a producer is feeding 10,000 heavy broilers?
    a. 3.90 $ft^3$ c. 390 $ft^3$
    b. 39.0 $ft^3$ d. 3900 $ft^3$

# APPENDIX L

# 2008 STATE AGRICULTURAL MECHANICS CDE

# TEAM ACTIVITY

| Team Members<br>Last Name(s) List All | Chapter<br># | Chapter Name | Total Score |
|---|---|---|---|
| 1.<br>2.<br>3.<br>4. | | | |

# Texas FFA Agricultural Mechanics Career Development Event

Hosted by Sam Houston State University
Sponsored by the Agricultural Consortium of Texas, and
Texas Agricultural Mechanics Committee
April 25, 2008

## Instructions

This is a team activity. You may work together as a group and solve problems and questions collectively or you may separate the problems of this activity and work independently. Keep in mind that other team members are near you, so work as quietly as possible. **Do not mark on the Fact Sheets** as other teams will reuse them. Use scratch paper for notes and calculations.

Point values for each question are listed as well as showing the steps in solving each problem. Remember the time—you have 60 minutes to complete this set of activities. When you have completely all sections, and if time is available, you may go to back double check your work and answers. **Return all sheets in their original numerical order**; raise your hand to signal for a group monitor to staple all papers together for scoring. – Good luck!

## SCORE SHEET

| ACTIVITY | Total Points | SCORE |
|---|---|---|
| **Problem #1—**Determining broiler farm water usage and pipe sizing | 48 | |
| **Problem #2—**Determining Ventilation Required to Keep Large Broilers Cool During Hot Weather | 37 | |
| **Problem #3—**Determining Best Performing Tunnel Fans | 40 | |
| **TOTALS** | 125 | |

# 2008
# Texas FFA Agricultural Mechanics Career Development Event

**Useful Formula:**
- ➢ 1 $ft^3$ = 7.410 gal.
- ➢ Air Flow in CFM (Q) = Flow Velocity in Feet Per Minute (V) x Duct Cross Sectional Area (A)
- ➢ Density of poultry manure is 62.2 $lb/ft^3$
- ➢ HP = rpm x T(torque) x 5252(constant)
- ➢ kwh= power x time
- ➢ Torque = Force x distance:
- ➢ 1 HP is equal to 550 pound-feet per second or 33,000 pound-feet per minute
- ➢ Water = 8.33 lbs/gal
- ➢ Watt = Volts x Amps x Power Factor (PF)

**Directions:**
As a team, you may work together, in groups, or as an individual in solving the problems. You may separate the three problems but should record all answers on **one final copy** to be turned in for scoring. Show the steps in solving each problem for full points.

**Team Problem Solving Activity Scenario**
Your School Board and School Administrators have approved the construction of retrofitting a poultry production facility for your FFA Chapter. They have asked your team to make recommendations for the water usage, ventilation requirements, and the best performing fans. The field staff of NRCS (Natural Resource Conservation Service) will check your calculations and approve your plans prior to construction.

## Problem #1—Determining broiler farm water usage and pipe sizing
**Reference Provided: Poultry Housing Tips: Broiler Farm Water Usage and Pipe Sizing Rules of Thumb. Vol 19, No 6. May 2007**
**http://www.engr.uga.edu/service/extension/ventilation/tips/2007/vol19n6.pdf**

## Problem #2—Determining Ventilation Required to Keep Large Broilers Cool During Hot Weather
**Reference Provided: What Does it Take to Keep Large Broilers Cool During Hot Weather? Vol 19, No 11. October 2007.**
**http://www.engr.uga.edu/service/extension/ventilation/tips/2007/vol19n11.pdf**

## Problem #3—Determining Best Performing Tunnel Fans
**Reference Provided: Best Performing Tunnel Fans - 2007 Vol 20, No 1. January 2008.**
**http://www.engr.uga.edu/service/extension/ventilation/tips/2008/vol20n1.pdf**

| Team Members<br>Last Name(s) List All | Chapter<br># | Chapter Name | Score<br>Problem #1 |
|---|---|---|---|
| 1.<br>2.<br>3.<br>4. | | | |

## Problem #1—Determining the broiler farm water usage and pipe sizing using the attached fact sheet volume 19 number 6

**Reference: http://www.engr.uga.edu/service/extension/ventilation/tips/2007/vol19n6.pdf**

**Given:** There are four (4) broiler houses on this location - 40 X 500' houses with 6" pads (240,000 cfm of tunnel fan capacity), 150 interior fogging nozzles, and 22,500 birds grown to 56 days

**Find: Water usage and pipe size for this site**

1.1. What is the formula for determining total peak farm water usage? (8 points)

Write it here:

1.2. What is the peak house water usage in gallons/minute for one house (gal/min)?

(Show steps of your work for full credit–+ 3pt; Total 10 points) ______________________________

1.3. What is the total peak farm water usage for the four (4) houses?

____________________
(Show steps of your work for full credit–+ 3pt; Total 10 points)

1.4. What is the minimum pipe size from the well to the first house?

____________________
(Show steps of your work for full credit–+ 3pt; Total 10 points)

1.5. What is the minimum pipe size from the third house to the fourth house? __________
(Show steps of your work for full credit–+ 3pt; Total 10 points)

## End of Problem #1—Determining the broiler farm water usage and pipe sizing using the attached fact sheet volume 19 number 6

| Team Members Last Name(s) List All | Chapter # | Chapter Name | Score Problem #2 |
|---|---|---|---|
| 1.<br>2.<br>3.<br>4. | | | |

## Problem #2—Determining the Ventilation Required to Keep Large Broilers Cool During Hot Weather

### Useful Formula

1 $ft^3$ = 7.410 gal.
kwh = watts x 1000 X time
Power =Amp X Watt
Watt = Volts x Amps x Power Factor (PF)
Air Flow in CFM (Q) = Flow Velocity in Feet Per Minute (V) x Duct Cross-Sectional Area (A)

**Reference: What Does it Take to Keep Large Broilers Cool During Hot Weather? Vol 19, No 11. October 2007.**
**http://www.engr.uga.edu/service/extension/ventilation/tips/2007/vol19n11.pdf**

**Given:** A broiler house is being retrofitted to grow birds that weigh in the 7 ½--8 pound range. The tunnel ventilation house is 50' X 9.75' X 500' house with 6" evaporating pads, 0.10" of static pressure, and will hold 22,500 birds grown to 63 days

**Find:**

2.1. What is the formula to determine air flow in cubic feet per minute in a broiler house?

(Total 7 pts) Write it here:

1.6. 2.2. What is the volume (cu/ft) of the retrofitted house? __________
(Show steps of your work for full credit–+ 3pt; Total 10 points)

2.3. What is the tunnel fan capacity (Q) required to obtain an air speed of 650 ft/min?

(Show steps of your work for full credit–+ 3pt; Total 10 points) ____________________

2.4. How many hi-flow fans (26,300 cfm) would be required for the retrofitted house?

(Show steps of your work for full credit–+ 3pt; Total 10 points) ____________________

### End of Problem #2—Determining the Ventilation Required to Keep Large Broilers Cool During Hot Weather

| Team Members<br>Last Name(s) List All | Chapter<br># | Chapter Name | Score<br>Problem #3 |
|---|---|---|---|
| 1.<br>2.<br>3.<br>4. | | | |

## Problem #3—Determining the Best Performing Tunnel Fans

**Reference Provided: Best Performing Tunnel Fans; 2007 Vol 20, No 1. Jan 2008.**
**http://www.engr.uga.edu/service/extension/ventilation/tips/2008/vol20n1.pdf**

**Given:** A broiler house is being retrofitted and needs to have new ventilations fans. The tunnel ventilation house is 50’ X 9.75’ X 500' house. Ventilation fans run an average of 4,000 hours per year. Minimum ventilation for this house is 300,000 cfm. Electricity costs $0.25/kwh.

**Find:**

3.1. Which fan manufacture/model has the highest air flow ratio? (Total 10 points)

Write manufacture/model number here: ________________________

3.2. Which fan manufacture/model has the highest air flow ratio when operating at 0.10” hg static pressure? (Total 10 points)

Write manufacture/model number here: ________________________________

3.3. Which fan manufacture/model has the highest air flow ratio when operating at 0.05”hg static pressure? (Total 10 points)

Write manufacture/model number here: ________________________________

3.4. If electricity costs $0.25/kwh, what is the annual difference in cost to ventilate one house using 12 Acme BDR54J operating at 0.05” hg static pressure when compared to 11 American Coolair MNEFC52M operating at 0.05” hg static pressure using test data from BESS Laboratory? (Show steps of your work for full credit–+ 3pt; Total 10 points). Your answer should identify the most economical fan and the annual cost savings

**Circle most efficient Mfg.** (Acme) / (American Coolair)

**Annual cost savings** $ ___________________

You may separate the sheets but should **record all answers on one final copy** to be turned in for scoring. Show the steps and label the units in solving each problem for full points.

**End of Problem #3—Determining the Best Performing Tunnel Fans**

# VITA

Kirk Clowe Edney received his Bachelor of Science degree in agricultural education and his secondary vocational agriculture / secondary science teacher certification from Texas A&M University in May 1975. He entered the Agricultural Education program at Tarleton State University in September 1979 and received his Master of Science – Teaching degree in August 1983. Edney earned his Doctor of Philosophy in Agricultural Leadership, Education and Communications from Texas A&M University in December 2009. His research interests include contextual mathematics, authentic assessment, instructional technology, and career and technical education.

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