THE INFLUENCE OF AGRISCIENCE RESEARCH ON HIGH SCHOOL STUDENTS' PERCEIVED SELF-EFFICACY OF 21ST CENTURY SKILLS ATTAINMENT

A Thesis
Submitted to the Graduate Faculty
of the
North Dakota State University
of Agriculture and Applied Science

By

Brooke Louise Thiel

In Partial Fulfillment of the Requirements
for the Degree of
MASTER OF SCIENCE

Major Program:
Agricultural Education

April 2017

Fargo, North Dakota

North Dakota State University
Graduate School

Title

THE INFLUENCE OF AGRISCIENCE RESEARCH ON HIGH SCHOOL STUDENTS' PERCEIVED SELF-EFFICACY OF 21ST CENTURY SKILLS ATTAINMENT

By

Brooke Louise Thiel

The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

MASTER OF SCIENCE

SUPERVISORY COMMITTEE:

Dr. Adam Marx
Chair

Dr. Larry Napoleon

Dr. Mari Borr

Dr. David Buchanan

Approved:

4/12/2017
Date

Dr. Adam Marx
Department Chair

ABSTRACT

The purpose of this study was to determine if student participation in agriscience research Supervised Agricultural Experiences (SAEs) contributed to the development of selected 21^{st} century skills. The target population was 10^{th}-12^{th} grade students enrolled in high schools purposely selected for their involvement in agriscience research SAEs. Total study participants included 328 (*N*) students from a purposive sample. Participants completed an instrument used to measure perceived self-efficacy of 21^{st} century skill attainment.

The results of the study indicate that students who were enrolled in agricultural education, were involved in SAEs, and participated in agriscience research reporter higher means of perceived self-efficacy of 21^{st} century skill attainment than their peers who were not engaged in those activities. However, the results were not significant based on the results of the independent samples *t*-test.

ACKNOWLEDGEMENTS

Completing my thesis has been one of the most challenging, yet rewarding, things I have done in my professional career. Many people deserve recognition for helping me get to this point. I am thankful to all of the individuals that pushed me to continue my education, even when it seemed like I would never reach the light at the end of the tunnel.

Thank you to Dr. Adam Marx for your patience and guidance through this research process. You taught me many things, but most of all, you taught me to enjoy research! Thank you for encouraging and pushing me to keep going even when I felt overwhelmed and unsure.

Thank you to Dr. Mari Borr, Dr. Larry Napoleon, and Dr. David Buchanan for serving on my committee. Your feedback and expertise throughout this process has been truly appreciated and valued.

To all of the North Dakota State University Faculty, I am thankful for the time you spent teaching courses and guiding me to where I am today. You all helped me become a better professional educator, while encouraging my love of learning.

Thank you to the high school agricultural education teachers that volunteered to assist with this study. Tony Boehm, Rebecca Haddad, and Mitchell Becker, I appreciate you taking time out of your already busy schedules to collect data for my study.

I owe Dr. R. Brent Young for getting me started on this journey. You pushed me to apply for graduate school and encouraged me to go above and beyond what was expected. I appreciate the opportunities you provided to me, and where they have led me to today.

I would not be the person or educator I am today without my students. I owe them everything. Thank you for allowing me to grow as a teacher and advisor. I will cherish the memories of teaching high school agriculture for the rest of my life.

DEDICATION

For my husband Patrick, thank you for your unending support and love. Thank you for enduring frozen pizza and instant meals while I tried to balance graduate school, work, and family. Your willingness to support me in my career means more to me than you will ever know.

For my parents, thank you for teaching me that education is priceless. You instilled within me a love for learning and a passion for teaching. Thank you for supporting me always and loving me unconditionally.

For my sisters Lindsey and Mairin, you allowed me to practice teaching long before I became a teacher! Thank you for your friendship and love. You have always sharpened me and pushed me to be my best. Thank you for always being there and for encouraging me to follow my dreams.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. CHAPTER ONE

1.1. Background and Setting

1.1.1. What is school-based Agricultural Education?

Comprehensive school-based agricultural education is composed of three equal components, often depicted as the three-circle model: classroom and laboratory instruction, FFA, and Supervised Agricultural Experience (SAE) (Dyer & Osborne, 1995; Roberts & Ball, 2009; Talbert, Vaughn, Croom, & Lee, 2007). Since its development, the purpose of school-based agricultural education has been to prepare students for careers in agriculture (Phipps, Osborne, Dyer, & Ball, 2008). Relevant, hands-on classroom and laboratory instruction allows students to study, learn concepts, and solve problems related to agriculture (Phipps et al., 2008; National FFA Organization, 2015). The purpose of FFA is to allow members to "develop premier leadership, personal growth, and career success through agricultural education" (National FFA Organization, 2015). The outcomes are observed through diverse activities including subject specific competitive events, leadership development, and service projects. The third component, SAE, provides students the opportunity to apply the skills and knowledge they attained in the classroom to real-life career-related activities outside of the classroom, through experiential learning opportunities specific to the student's career interests (Phipps et al., 2008).

1.1.2. Theoretical Foundations of Agricultural Education

Experiential learning has been the cornerstone of agricultural education (Cheek, Arrington, Carter, & Randell, 1994; Roberts, 2006; Stewart & Birkenholz, 1991; & Knobloch, 2003). According to Kolb (1984), experiential "learning is the process whereby knowledge is created through the transformation of experience" (p. 38).

Unlike teacher-centered instruction, experiential learning places the responsibility of learning with the learner (Caulfield, 2011). Baker, Robinson, and Kolb (2012) concluded experiential learning should be incorporated into all three components of school-based agricultural education programs. Though experiential learning is most commonly associated with SAEs in agricultural education, Knobloch (2003) defined experiential learning beyond SAEs as real-life learning in which students complete tasks, solve problems, or conduct projects in the classroom and within FFA engagement.

1.1.3. What is Supervised Agricultural Experience (SAE)?

In the context of agricultural education, one way experiential learning manifests itself is in the form of Supervised Agricultural Experience (SAE) programs. SAE is an integral part of a comprehensive, school-based agricultural education program (Camp, Clarke, & Fallon, 2000; Talbert et al., 2007, Phipps et al., 2008; Dyer & Williams, 1997; Cheek et al., 1994). SAEs provide students the opportunity to apply what they learned in the classroom to real-world agriculturally related work experiences (Phipps et al., 2008; Talbert et al., 2007; Cheek, et al., 1994; Camp et al., 2000). Those real-world experiences can be in the form of ownership/entrepreneurship, placement/internship, agriscience research, exploratory, school-based enterprise, and service-learning (National Council for Agricultural Education, 2015).

Cheek et al. (1994) found that student involvement in SAE was positively related to student achievement in agriscience classes. Dyer and Williams (1997) summarized the benefits of SAE as preparing people for jobs in agriculture, developing agricultural knowledge, and instilling positive work ethics. Through involvement in SAEs, teachers report the attainment of entry-level technical skills within career pathways ranging from the administration of medications to calculating simple interest (Ramsey & Edwards, 2012). In addition, teacher perceived benefits of student participation in SAEs in Missouri included developing desirable work habits, increasing responsibilities, maintaining records, developing skills in agriculture, and achieving occupational goals (Stewart & Birkenholz, 1991).

Talbert et al. (2007) described the following as benefits that students indicated they gained through SAE participation:

> Development of decision-making skills, improved self-confidence and human-relation skills, application of knowledge learned in the classroom, development of time-management and record-keeping skills, discovery of areas of personal interest, practice of responsibility and development of independence. (p. 420-421).

The benefits of SAE to students further demonstrate the interdependence of the three-circle model of agricultural education because students attain additional skills when given the opportunity to apply what they have learned in the classroom to out of class, real-world career experiences. Without SAE as a part of the three-circle model, students may be limited in the opportunities to gain agriculturally related skills at the secondary level.

1.1.4. Issues with SAE in Agricultural Education

According to Retallick and Martin (2008), traditional production ownership SAEs in Iowa are decreasing by 0.54% per year. In recent decades, there has been a shift in agricultural education. When the Smith-Hughes Act of 1917 passed, it designed school-based agricultural education for people currently working or preparing to work on farms (Phipps et al., 2008). Thus, SAEs were primarily entrepreneurship/ownership or placement at the time, which defines them as traditional SAEs (Bird, Martin, & Simonsen, 2013). By contrast, nontraditional SAEs include service-learning, exploratory, school-based enterprises, and agriscience research.

However, in recent years, 73% of students enrolled in agricultural education do not live on farms (Phipps et al., 2008). In addition to students not living on farms, there has been a decreased need for farm labor in the United States as the number of farms continues to decrease and labor needs are replaced through mechanization (National Agricultural Statistics Service, 2009). Though the foundation upon which school-based agricultural education was built is still relevant to the percentage of students living on farms or pursuing careers in production agriculture, the focus of agricultural education needs to be expanded to include other career opportunities in order to benefit a larger percentage of enrolled students (Camp, Clarke, & Fallon, 2000).

Moreover, total SAE involvement is in decline (Dyer & Osborne, 1995; Steele, 1997; Retallick & Martin, 2008). A study by Retallick and Martin (2008), conducted in Iowa, found a growing gap between the number of students enrolled in agricultural education and those who participate in SAE. In the early 1990's, over 85% of agricultural education students conducted SAEs, while in 2005, that number had dropped to only 56% (Retallick & Martin, 2008). Nonetheless, agricultural educators across the country agree SAE should remain an integral component of school-based agricultural education (Camp et al., 2000). Consequently, SAE must keep up with the trends and changes in agricultural education and change to meet the needs and demands of students that will be pursuing agricultural careers in the new century (Camp et al., 2000). This can be accomplished through greater utilization of nontraditional SAE areas such as agriscience research, exploratory activities, and service-learning. Whereas traditional SAEs, such as entrepreneurship/ownership and placement, require resources such as land, livestock, or capital and opportunities such as access to farms and agribusinesses (Phipps et al., 2008), nontraditional SAEs, such as agriscience research, may provide students more flexible opportunities that can be more effectively utilized in urban and suburban settings. Since more students in agricultural education are coming from urban and suburban backgrounds, the more flexible opportunities offered by nontraditional SAEs may meet the needs of a growing demographic of agricultural education students.

1.1.5. Agriscience Research SAEs

Agriscience research is one of the nontraditional SAEs that is well-suited for integration into urban and suburban agricultural education programs. The utilization of agriscience research SAEs may be one way the SAE program can continue to find relevance and value with current agricultural education students. Though it is not a new SAE area, interest in agriscience research as an SAE is growing. For example, in Iowa, agriscience research projects as SAEs are increasing at a rate of 14.27% per year, which is relatively dramatic compared to the eight percent increase per year in placement SAEs or the 0.54% decrease in entrepreneurship SAEs (Retallick & Martin, 2008).

According to the National Council for Agricultural Education (2015), there are three types of agriscience research SAEs: experimental, analytical, and invention. Experimental SAEs require a student to plan and implement an agricultural experiment utilizing the scientific process. Through an experimental SAE, students identify problems or questions, develop a hypothesis, test the hypothesis using scientific methods, verify prior research with results, and discover new knowledge (National Council for Agricultural Education, 2015). The requirements of an experimental agriscience research SAE mirror what the National Research Council defines as necessary components of inquiry-based education: 1. engagement in scientifically oriented questions, 2. utilization of evidence to evaluate questions, 3. development of ideas based on evidence, 4. connecting explanations to scientific knowledge, and 5. communication and justification of scientific explanations (National Research Council, 2000). A review of research by Haury (1993) concluded that inquiry-based teaching led to the outcomes of improved scientific literacy, critical thinking, and communication skills. Plausibly, student engagement in experimental agriscience research SAEs would lead to those same outcomes.

1.1.6. Agricultural Education and 21st Century Skills

In recent years, there has been an increased emphasis on college and career readiness, which has led to a shift towards the development of 21st century skills (Trilling & Fadel, 2009). The Partnership for 21st Century Skills identifies the following skills as 21st century skills for today's students: creativity and innovation, critical thinking and problem solving, communication and collaboration, information literacy, media literacy, information and communications technology literacy, flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, and leadership and responsibility (Partnership for 21st Century Skills, 2014).

Many of the skills students develop through Career and Technical Student Organizations (CTSOs) align with 21st century skills. As outlined in the Carl D Perkins Act of 2006 and supported through research in agricultural education, CTSOs, such as FFA, were developed to allow students to (a) develop leadership skills (Rosch, Simonsen, & Velez, 2015; Townsend & Carter, 1983); (b) cultivate personal growth; (c) explore careers (Lundry, Ramsey, Edwards, & Robinson, 2015); (d) improve home and family; (e) develop citizenship and patriotism (Townsend & Carter, 1983); (f) improve scholarship and vocational preparation (Sapp & Thoron, 2014); (g) improve school and community; (h) develop respect for dignity and work (Lundry et al., 2015); (i) develop high ethical and moral standards; (j) participate in cooperative efforts (Lundry et al., 2015; Townsend & Carter, 1983); (k) develop creativity (Lundry et al., 2015); and (l) develop social skills (Carl D. Perkins Act, 2006). Therefore, research shows that 21st century skills are developed through involvement in FFA, a component of the three-circle model of agricultural education. Is it possible that those same skills could also be attained through another component of the three-circle model: SAE?

1.2. Theoretical Framework

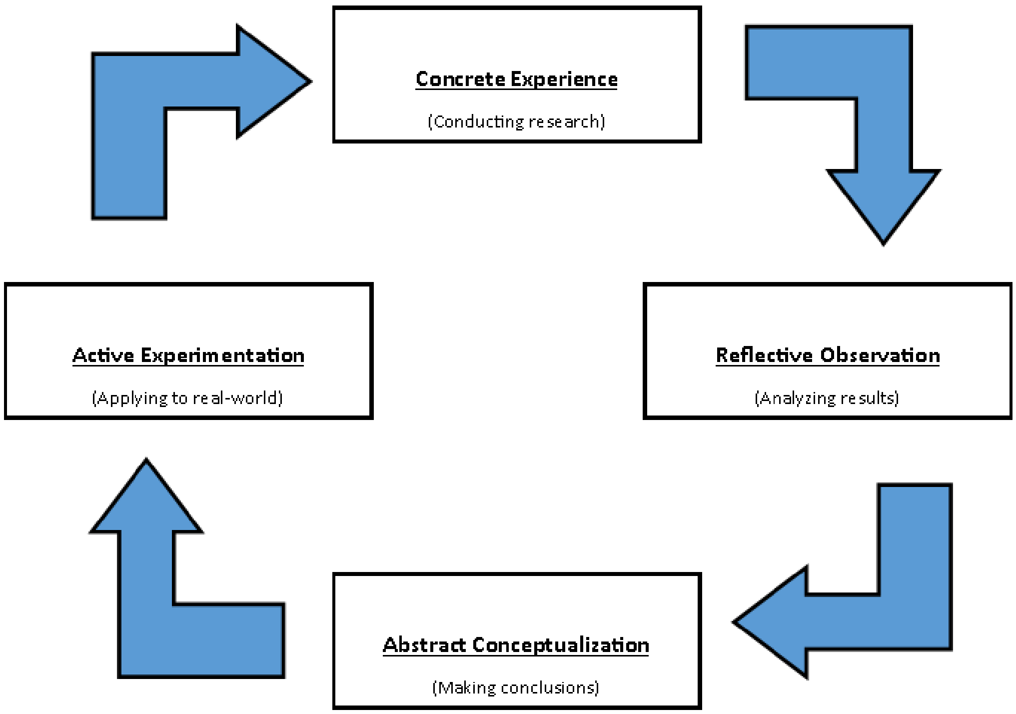


Figure 1. Agriscience research as it relates to Kolb's Experiential Learning Theory. This figure illustrates how the stages of agriscience research fit into the four-stage cycle of Kolb's Experiential Learning Theory.

Learning is the "process whereby knowledge is created through the transformation of experience" (Kolb, 1984, p. 38). Kolb's Experiential Learning Theory is a four stage continuous cycle that includes 1. concrete experience, 2. reflective observation, 3. abstract conceptualization, and 4. active experimentation (Kolb, 1984). Kolb developed and published his Experiential Learning Theory in 1984 in his book *Experiential Learning: Experience as a Source of Learning and Development*. This theory states that if a person were to go through the four cycles of experiential learning, then they will learn or create knowledge. As applied to this study, this theory holds that if a secondary student were to participate in an agriscience research SAE, which requires a student to go through the four cycles of Kolb's Experiential Learning Theory, then they will develop 21st century skills. This is plausible, because prior research shows that students create knowledge via experiential learning through Kolb's Experiential Learning Theory (Baker et al., 2012).

Kolb's Experiential Learning Theory should be embedded in all three components of a comprehensive, school-based agricultural education program (Baker et al., 2012). The premise of this study is based on the idea that Kolb's Experiential Learning Theory is expressed through agriscience research SAEs. Therefore, the outcome would be that 21st century skills could be learned through agriscience research SAEs. First, students identify a problem and develop a hypothesis. As they test their hypothesis, the actual experiment manifests as the concrete experience. Next, students evaluate their results, which involves them in the reflective observation stage. While reflecting, they will confirm or deny their hypothesis, evaluate sources of error, and identify discrepancies and patterns in their data. Movement into the abstract conceptualization stage would be evident as students make conclusions based upon their data. Their time in the reflective observation stage may lead them to develop new ideas and/or revise their original idea within the abstract conceptualization stage. Finally, as they apply their results and conclusions to real-world applications, the student would move into the active experimentation stage. In the case that the student starts to reinterpret their experience and develop their thoughts into new research ideas, they would move back into the concrete experience stage and begin the cycle again. This cycle could continue throughout a student's high school SAE.

Within the model of Kolb's Experiential Learning Theory, the basis of this study is built upon the assumption that students participating in agriscience research would attain 21st century skills through their SAE, a form of experiential learning, and that they would be able to recognize the development of those skills. Accountability, initiative, and self-direction are refined through active experimentation. In order to reflect through reflective observation, a student must use critical thinking and problem solving skills. Further, as students go through abstract conceptualization, they practice creative thinking and innovation. Finally, communication skills are developed through active experimentation in order to apply their findings to the real world and communicate their results. Movement back into the concrete experience also leads to adaptability skills as students work to re-test their hypothesis and act on new ideas.

1.3. Problem Statement

SAE involvement within school-based agricultural education is in a nationwide decline (Dyer & Osborne, 1995; Steele, 1997; Retallick & Martin, 2008), yet agricultural education instructors agree that SAE should continue to be an integral part of the agricultural education model and empirical evidence supports the benefits of SAE. Additionally, each year, fewer and fewer students enrolled in school-based agricultural education are coming from production agriculture backgrounds, which means that there are limited opportunities for production agriculture SAEs and on-farm placements. These challenges beg the question; how can the complete agricultural education program meet the needs of the students enrolled in programs across the nation?

Agriscience research is an increasingly popular SAE area. The format of an experimental. agriscience research SAE aligns closely with inquiry based teaching methods. Many experts agree that inquiry based teaching methods lead to the attainment of 21^{st} century skills, such as critical thinking and communication skills. Plausibly, agriscience research may encourage the same.

Ultimately, the purpose of school-based agricultural education is to prepare students for careers in agriculture. In order to prepare students for 21st century careers, focus needs to also be directed at promoting the development of 21^{st} century skills. How might the implementation of agriscience research SAEs, within a comprehensive, school-based agricultural education program, enhance the development of 21^{st} century skills?

1.4. Purpose of the Study

The purpose of this descriptive, exploratory study was to determine if student participation in agriscience research SAEs contributed to the development of selected 21^{st} century skills, including critical thinking and problem solving, creativity and innovation, communication and collaboration, information literacy, media literacy, ICT (Information, Communications, and Technology) literacy, flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, and leadership and responsibility.

1.5. Research Objectives

1. Describe student involvement in agriscience research SAEs.
2. Describe student’s perceptions of their current level of identified 21^{st} century skills.
3. Describe the relationship between 21^{st} century skills and agriscience research involvement.
4. Describe the relationship between 21^{st} century skills and SAEs.

5. Compare student perceptions of their current level of identified 21st century skills between students enrolled in school based agricultural education and those not enrolled in school based agricultural education.
6. Validate an instrument used to measure perceived attainment of 21st century skills.

1.6. Need for the Study

Public education in the United States is constantly changing. In recent years, there has been considerable emphasis placed on academic standards, data-driven instruction, and high-stakes assessment. Agricultural education has not been immune to those changes. In addition to teaching agricultural content, agriculture teachers need to support school-wide academic goals by integrating reading, writing, science, and mathematics into their classrooms (Stewart & Moore, 2004). Can these goals be met without changing the foundation upon which school-based agricultural education was developed?

The perpetual question, as education changes, has always been "how does agricultural education remain relevant and competitive in the 21st century?" (Camp, Clarke, & Fallon, 2000; Dailey, Conroy, & Shelley-Tolbert, 2001). Further, how do agricultural education teachers communicate the value of their programs to stakeholders, administrators, and legislators?

By measuring outcomes in the form of 21st century skills, the results of this study will be communicated in a manner that is understood outside of agricultural education as well as within it. Additionally, there is limited empirical evidence concerning the value of agriscience research SAEs. Since this is a growing SAE area, this research will validate its relevance and value within the model of agricultural education.

1.7. Limitations

The researcher identified the following limitations:

1. Due to the research design, the subjects selected for study represent a purposive sample. Consequently, the results are not generalizable beyond the respondents.
2. The instrument was administered and collected in one sampling at one point in time. Those not in attendance and non-respondents were not followed up on.
3. The convenience sample limited statistical analysis options.
4. Confounding variables were not controlled for in the study. Variables such as scientific experience outside of agricultural education was not controlled. Achieving student heterogeneity was attempted through selecting schools with similar involvement in SAE and agriscience research, but not controlled for in this study. Not all of the schools had the same number of students enrolled in agricultural education or involvement in SAE or agriscience research.

1.8. Definitions

The following definitions were provided for reader clarity. Each is used periodically throughout the chapters of the thesis.

School-based Agricultural Education: An educational program delivered through Career and Technical Education using three equal components: classroom and laboratory instruction, FFA, and SAE.

Supervised Agricultural Experience (SAE): A required component of a comprehensive, school-based, agricultural education program. A method of experiential learning which involves agricultural education students in out-of-classroom work experiences (National Council for Agricultural Education, 2015).

FFA: An intercurricular student organization for those interested in agriculture and leadership. One of the three components of school-based agricultural education.

Experiential Learning: the process whereby knowledge is created through the transformation of experience (Kolb, 1984).

21st Century Skills: skills, knowledge and expertise students must master to succeed in work and life; it is a blend of content knowledge, specific skills, expertise and literacies (Partnership for 21st Century Skills, 2015).

Entrepreneurship SAE: An SAE that involves the student planning, implementing, and operating an agriculturally related business (National Council for Agricultural Education, 2015).

Placement SAE: An SAE that involves the placement of a student within an agricultural business, on a farm or ranch, or in a school laboratory where they are either paid or unpaid for their time (National Council for Agricultural Education, 2015).

Exploratory SAE: An SAE designed to help students become aware of the various SAE opportunities or agricultural careers. Meant to help students select potential SAEs in the future (National Council for Agricultural Education, 2015).

School-based enterprise SAE: A student-managed operation within a school setting. Examples include school gardens and land-labs, production greenhouses, school stores, or equipment maintenance services (National Council for Agricultural Education, 2015).

Service-learning SAE: A student-managed service activity that involves the student managing the planning, organizing, implementing, and follow-up of the service project (National Council for Agricultural Education, 2015).

Agriscience research SAE: A student-managed activity that involves conducting research or discovering new knowledge.

Traditional SAEs: Entrepreneurship and placement SAEs.

Nontraditional SAEs: Exploratory, school-based enterprise, service-learning, and agriscience research SAEs.

1.9. Assumptions

The following assumptions guided this study:

1. The students participating in this study were all high school students in grades 10-12 at Richland 44 High School in Colfax, North Dakota, Kindred High School in Kindred, North Dakota, and Glencoe-Silver Lake High School in Glencoe, MN.
2. The students honestly and objectively reflected upon their current level of 21st century skills.
3. The students honestly reported personal demographic information.
4. The students accurately read and considered the instructions for completing the instrument.

2. CHAPTER TWO

2.1. Review of Literature

2.1.1. What is school-based Agricultural Education?

When the Morrill Land Grant Act was passed in 1862, there was virtually no agricultural education being taught at the secondary level (Phipps, Osborne, Dyer, & Ball, 2008). It was not until the early 1900's that colleges began advocating the teaching of agriculture at the secondary level to prepare students for the study of agriculture at the post-secondary level (Phipps et al., 2008). Individual states began to pass legislation that provided funding which allowed for instruction in agriculture at the secondary level (Phipps et al., 2008). In 1917, the Smith Hughes Act was passed, providing federal funds to public schools for vocational agricultural education programs that provided directed or supervised practice in agriculture (Phipps et al., 2008). It was the Smith Hughes Act of 1917 that led to the initial creation of school-based agriculture, even if other legislation has changed and shaped it into the school-based agricultural education of today (Phipps et al., 2008).

Comprehensive school-based agricultural education is composed of three equal components: classroom and laboratory instruction, FFA, and Supervised Agricultural Experience (SAE) (Dyers & Osborne, 1995; Roberts & Ball, 2009; Talbert, Vaughn, Croom, & Lee, 2007). Since its development, the purpose of school-based agricultural education has been to prepare students for careers in agriculture (Phipps et al., 2008). Relevant, hands-on classroom and laboratory instruction allows students to study, learn concepts, and solve problems related to agriculture (Phipps et al., 2008; National FFA Organization, 2015). The purpose of FFA is to allow members to "develop premier leadership, personal growth, and career success through agricultural education" (National FFA Organization, 2015, p 7). The outcomes are seen through diverse activities including subject specific competitive events, leadership development, and service projects. The third component, SAE, provides students the opportunity to apply the skills and knowledge they attained in the classroom to real-life career-related activities outside of the classroom, through experiential learning opportunities specific to the student's career interests (Phipps et al., 2008).

2.1.2. Theoretical Foundations of Agricultural Education

The foundation of agricultural education, since its beginning, has been experiential learning (Cheek, Arrington, Carter, & Randell, 1994; Roberts, 2006; Stewart & Birkenholz, 1991; & Knobloch, 2003). John Dewey originally proposed the theory of experiential learning when he claimed that learning comes from experience (Caulfield, 2011). Similarly, Kolb (1984) defined experiential learning as "the process whereby knowledge is created through the transformation of experience" (p. 38). Experiential learning involves a direct learning event or experience, which requires active engagement in that learning event by the student (Clark, Threeton, & Ewing, 2010). Though experiential learning is unlike teacher-centered instruction, which leads to passive engagement and limited student involvement with the learning process (Clark et al., 2010), the role of the teacher is still important according to Dewey. Dewey deemed the role of the learner was to construct knowledge through experience, whereas the role of the teacher was to assess a learner's readiness and ability to learn and to provide appropriate experiences to the learner (Caulfield, 2011).

There are many experiential learning theories, though there are recurring similarities between many of them. According to Dewey, through experiential learning, the learner becomes able to build new knowledge through observation, experience, and reflection (Caulfield, 2011). Kolb's Cycle of Learning Modes, which has been incorporated within agricultural education

(Baker, Robinson, & Kolb, 2012; Shoulders & Myers, 2013; Roberts, 2006), includes four phases: 1. Concrete experience, 2. Reflective observation, 3. Abstract conceptualization, and 4. Active Experimentation (Nilson, 2010, p. 63). Roberts (2006) modeled the similarities between Kolb, Joplin, and Dewey. Consistently, all three theories are cyclical, indicating that the process of experiential learning is life-long and on-going (Roberts, 2006). Additionally, experiential learning requires students to have a direct experience, which then leads the learner to reflect on the experience and develop theories and ideas related to that experience (Roberts, 2006). Finally, those ideas are tested through the continuation of the cycle (Roberts, 2006). Roberts (2006) combined those theories into the Model of the Experiential Learning Process (Figure 2).

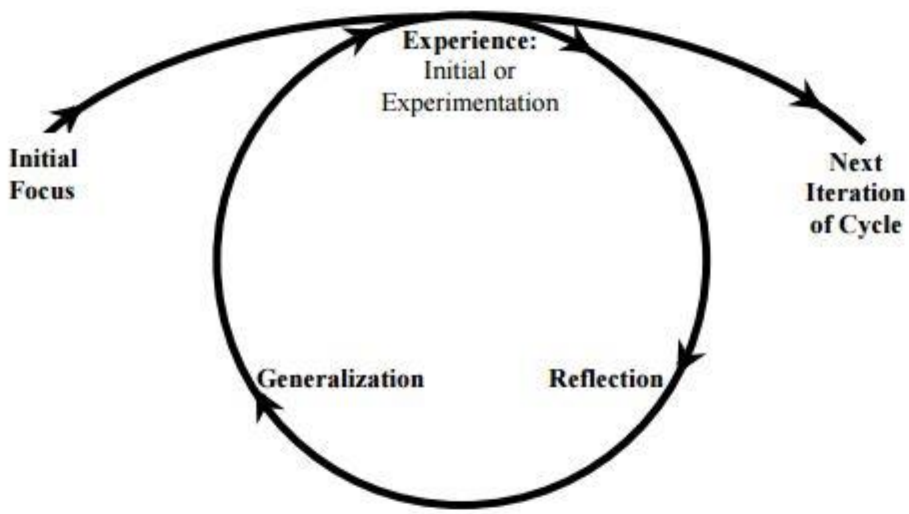


Figure 2. Roberts Model of the Experiential Learning Process. This figure combines the theories of Kolb, Joplin and Dewey into a cyclical figure that demonstrates the inter-connectedness and similarities between three major experiential learning theories (Roberts, 2006).

Because experiential learning is conceptually based on experiences, it is most commonly associated with SAEs in agricultural education (Cheek et al., 1994; Knobloch, 2003; Roberts, 2006). However, experiential learning should be incorporated into all three components of school-based agricultural education programs (Baker et al., 2012). Research within agricultural education has validated that experiential learning is a relevant and effective framework for agricultural education programs, teachers, and students (Knobloch, 2003). Beyond SAEs, experiential learning can be defined as real-life learning in which students complete tasks, solve problems, or conduct projects in the classroom and within FFA engagement (Knobloch, 2003). Experiential learning is diverse and can be implemented through laboratory research, problem solving in the classroom, internships, and field trips (Roberts, 2006).

Unfortunately, Clark et al. (2010) believe that experiential learning, as it is currently being used within agricultural education, is not truly experiential learning. While utilizing experiential learning experiences, agricultural educators rarely provide opportunities for active experimentation or internal reflection (Osborne, 1994). In a study by Shoulders and Myers (2013), the most commonly omitted stage of experiential learning was active experimentation. The statement "learning by doing" is commonly utilized within agricultural education (Phipps et al., 2008), however, that practice only uses part of the experiential learning theory as it places the entire focus on concrete experiences, rather than on the holistic process of experiential learning, which should also include reflection and active experimentation (Clark et al., 2010). Experiential learning needs to be more than just the experience (Roberts, 2006).

2.1 3. What is Supervised Agricultural Experience (SAE)?

One expression of experiential learning, Supervised Agricultural Experience (SAE) is an integral part of a comprehensive, school-based agricultural education program (Camp, Clarke, & Fallon, 2000; Talbert et al., 2007, Phipps et al., 2008; Dyer & Williams, 1997; Cheek et al., 1994). According to Caulfield (2011), placing the responsibility of learning with the learner, unlike teacher-centered instruction, is the key to experiential learning. In an effort to engage students in experiential learning, students must be allowed the opportunity to identify areas of interest upon which they can develop their SAEs (Baker et al., 2012).

Being student-centered does not negate the need for teachers to be involved in SAEs. Experiential learning does require planning and meaningful support from an instructor and the learning experience should be assessed (Baker et al., 2012). Additionally, experiential learning should lead to the acquisition of specific, intentionally planned skills as an outcome (Baker et al., 2012). It is, therefore, necessary that classroom instruction precedes SAE to allow for the transfer of planned skills to real-world agriculturally related work experiences (Phipps et al., 2008; Talbert et al., 2007; Cheek et al., 1994; Camp et al., 2000; Baker et al., 2012). Those real-world experiences can be in the form of ownership/entrepreneurship, placement/internship, agriscience research, exploratory, school-based enterprise, and service-learning (National Council for Agricultural Education, 2015).

Cheek et al. (1994) found that student involvement in supervised agricultural experiences was positively related to student achievement in agriscience classes. Dyer and Williams (1997) summarized the benefits of SAE as preparing people for jobs in agriculture, developing agricultural knowledge, and instilling positive work ethics. Through involvement in SAEs, teachers report the attainment of entry-level technical skills within career pathways ranging from the administration of medications to calculating simple interest (Ramsey & Edwards, 2012). In addition, teacher-perceived benefits of student participation in SAEs in Missouri included developing desirable work habits, increasing responsibilities, maintaining records, developing skills in agriculture, and achieving occupational goals (Stewart & Birkenholz, 1991).

Talbert et al. (2007) listed the following as benefits that students indicated they gained through SAE participation:

> Development of decision-making skills, improved self-confidence and human-relation skills, application of knowledge learned in the classroom, development of

> time-management and record-keeping skills, discovery of areas of personal interest, practice of responsibility and development of independence. (p. 420-421).

The benefits of SAE to students and the cyclical nature of experiential learning further demonstrate the interdependence of comprehensive, school-based agricultural education because students attain additional skills when given the opportunity to transfer and apply what they have learned in the classroom to out of class, real-world career experiences. Without SAE as a part of a comprehensive, school-based agricultural education program, students may be limited in the skills they could potentially attain at the secondary level.

2.1.4. Issues in Agricultural Education

In 1963, Congress passed the Vocational Education Act of 1963. The purpose of the act was to expand vocational education across the nation (Phipps et al., 2007). Unfortunately, the act led to a slow, steady decrease in SAEs nationwide due to the removal of the requirements set forth in the Smith-Hughes Act that mandated student SAEs and the reduction of extended summer-teaching contracts that allowed agricultural educators to supervise SAEs in the summer (Phipps et al., 2007).

Total SAE involvement is in decline (Dyer & Osborne, 1995; Steele, 1997; Retallick & Martin, 2008; Croom, 2008). A study by Retallick and Martin (2008), conducted in Iowa, found a growing gap between the number of students enrolled in agricultural education and those who participate in SAE. In the early 1990's, over 85% of agricultural education students conducted SAEs, while in 2005, that number had dropped to only 56% (Retallick & Martin, 2008). Only 46% of students surveyed in Florida, Indiana, Missouri, and Utah reported having SAEs (Lewis, Rayfield, and Moore, 2012).

Many studies have been conducted to determine some of the barriers and obstacles that are preventing SAE involvement in the 21st century. Wilson and Moore (2007) found that FFA limits the amount of time teachers have to supervise SAE projects. Another factor that may cause lower SAE involvement was that teachers receive more community support and recognition for FFA activities rather than SAE projects (Wilson & Moore, 2007). Also, many teachers believe that there are limited opportunities for SAE involvement in their communities (Wilson & Moore, 2007). Retallick (2007) found that teachers had difficulties implementing SAEs due to limited resources and opportunities for traditional production ownership SAEs. Additional factors that may be causing a decrease in SAE involvement, identified by agricultural education instructors, include lack of time, increased number of students, complicated record keeping, lack of facilities, low student desire, lack of agricultural background, and lack of knowledge of the newer SAE categories (Lewis et al., 2012; Steele, 1997; Wilson & Moore, 2007).

Compounding those challenges, there has been a shift in agricultural education. When the Smith-Hughes Act of 1917 passed, it designed school-based agricultural education for people currently working or preparing to work on farms (Phipps et al., 2008). Thus, SAEs were primarily entrepreneurship/ownership or placement at the time (Bird, Martin, & Simonsen, 2013). However, in 2008, 73% of students enrolled in agricultural education did not live on farms (Phipps et al., 2008). In addition to students not living on farms, there has been a decreased need for farm labor in the United States as the number of farms continues to decrease and labor needs are replaced through mechanization (National Agricultural Statistics Service, 2009). This shift may be what has led to the reduction in traditional production ownership SAEs by 0.54% per year in Iowa (Retallick & Martin, 2008).

Nonetheless, agricultural educators across the country agree SAE should remain an integral component of school-based agricultural education (Camp et al., 2000; Wilson & Moore, 2007). Consequently, SAE must keep up with the trends and changes in agricultural education and change to meet the needs and demands of students that will be pursuing agricultural careers in the new century (Camp et al., 2000). This can be accomplished through greater utilization of nontraditional SAE areas such as agriscience research, exploratory, and service-learning. Though the foundation upon which school-based agricultural education was built is still relevant to the percentage of students living on farms or pursuing careers in production agriculture, the focus of agricultural education needs to be expanded to include other career opportunities in order to benefit a larger percentage of enrolled students (Camp et al., 2000). Whereas traditional SAEs, such as entrepreneurship/ownership and placement, typically require resources such as land, livestock, or capital and opportunities such as access to farms and agribusinesses, nontraditional SAEs may provide students more flexible opportunities that can be more effectively utilized in urban and suburban settings. Since more students in agricultural education are coming from urban and suburban backgrounds, the more flexible opportunities offered by nontraditional SAEs may meet the needs of a growing demographic of agricultural education students.

2.1.5. Agriscience Research SAEs

Agriscience research is one of the nontraditional SAEs well-suited to be integrated into urban and suburban agricultural education programs. The utilization of agriscience research SAEs may be one way the SAE program can continue to find relevance and value with current agricultural education students. Though it is not a new SAE area, interest in agriscience research as an SAE is growing. For example, in Iowa, agriscience research projects as SAEs are increasing at a rate of 14.27% per year (Retallick & Martin, 2008). In North Carolina, 26.3% of teachers reported having one or more students involved in agriscience research as an SAE (Wilson and Moore, 2007).

According to the National Council for Agricultural Education (2015), there are three types of agriscience research SAEs: experimental, analytical, and invention. Analytical SAEs would involve a student choosing a real-world problem, gathering and evaluating data, and producing a finished product (National Council for Agricultural Education, 2015). Examples of finished products may include a landscape design or a marketing plan. Invention SAEs would engage the student in the development or improvement of a product within the agriculture industry (National Council for Agricultural Education, 2015). Experimental SAEs require a student to plan and implement an agricultural experiment utilizing the scientific process. Through an experimental SAE, students identify problems or questions, develop a hypothesis, test the hypothesis using scientific methods, verify prior research with results, and discover new knowledge (National Council for Agricultural Education, 2015). The requirements of an experimental agriscience research SAE mirror what the National Research Council defines as necessary components of inquiry-based education: 1. engagement in scientifically oriented questions, 2. utilization of evidence to evaluate questions, 3. development of ideas based on evidence, 4. connecting explanations to scientific knowledge, and 5. communication and justification of scientific explanations (National Research Council, 2000). Plausibly, student engagement in experimental agriscience research SAEs would lead to those same outcomes.

A review of research by Haury (1993) concluded that inquiry-based teaching led to the outcomes of improved scientific literacy, critical thinking, and communication skills. Inquiry-based teaching leads students to think critically (Thoron & Myers, 2012; Mabie & Baker, 1996; Haury, 1993). Experiential learning activities improved students' ability to observe, communicate, compare, relate, order, and infer, all of which are essential components of inquiry (Mabie & Baker, 1996).

As an additional benefit, agriscience research SAEs can lead to opportunities for recognition within FFA. In 1988, the first regional Agriscience Student Scholarship and Recognition Program award was given out, followed by the first national award in 1989 (National FFA Archives, 2015). The wave of interest in agriscience research led to the addition of the National Agriscience Fair in 1998 and the first American Star in Agriscience in 2001 (National FFA Archives, 2015). Currently, there are three agriscience research proficiency award areas available to students for recognition of their outstanding agriscience research SAEs (National FFA, 2015).

Even though it is more likely that a student would earn money through a placement or entrepreneurship SAE, students involved in agriscience research can earn funds through awards and recognition as well (National FFA Organization, 2015). Some students pursue research SAEs as part of a paid job, working for agriscience companies or the university extension service (National FFA Organization, 2016). Finally, some students may earn grants, stipends, or scholarships to conduct their research SAEs (Kohn, 2014).

The additional opportunity for recognition within FFA and the ability to make some income through their SAE may be the motivation necessary to gain support from agricultural educators that struggle balancing the three components of a comprehensive, school-based agricultural education program. In addition to the challenge of finding time to implement both FFA and SAE equally, the effort to increase the rigor of the classroom component of school-based agricultural education, which creates its own set of challenges, has continued to rise in recent years.

2.1.6. Agricultural Education and 21st Century Skills

Nationwide, there has been a push towards increased academic standards, accountability, and rigor in secondary agricultural education. In an effort to continue aligning agricultural education curriculum with national standards in mathematics, science, social studies, and English language arts, The National Council for Agricultural Education developed and released a set of national standards in 2009, which were revised in 2015, that align agricultural education standards with core academic standards (National Council for Agricultural Education, 2015). Furthermore, as part of the National Quality Program Standards, which are benchmark standards used to evaluate agricultural education programs, academic content standards must be aligned with technical agriculture content by agricultural education programs (National Council for Agricultural Education, 2016).

In addition to the push towards accountability and standards, there has been an increased emphasis placed on college and career readiness. Many in education believe that American education needs to make a shift towards 21st century skills (Trilling & Fadel, 2009). The Partnership for 21st Century Skills (2015) summarizes the following skills as 21st century skills: creativity and innovation, critical thinking and problem solving, communication and collaboration, information literacy, media literacy, information and communications technology literacy, flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, and leadership and responsibility. It is those applied skills such as critical thinking, communication, information technology, creativity and innovation, and teamwork that employers seek in today's employees (Rateau, Kaufman, & Cletzer, 2015). According to Casner-Lotto, Barrington, and Wright (2006), the five most important applied skills for graduates, which align closely with the 21st century skills previously outlined, are oral communication, teamwork and collaboration, professionalism and work ethic, written communications, and critical thinking and problem solving.

Many of the skills students develop through Career and Technical Student Organizations (CTSOs) align with 21st century skills. As outlined in the Carl D Perkins Act of 2006 and supported through research in agricultural education, CTSOs, such as FFA, were developed to allow students to (a) develop leadership skills (Rosch, Simonsen, & Velez, 2015; Townsend & Carter, 1983); (b) cultivate personal growth; (c) explore careers (Lundry, Ramsey, Edwards, & Robinson, 2015); (d) improve home and family; (e) develop citizenship and patriotism (Townsend & Carter, 1983); (f) improve scholarship and vocational preparation (Sapp & Thoron, 2014); (g) improve school and community; (h) develop respect for dignity and work (Lundry et al., 2015); (i) develop high ethical and moral standards; (j) participate in cooperative efforts (Lundry et al., 2015; Townsend & Carter, 1983); (k) develop creativity (Lundry et al., 2015); and (l) develop social skills (Carl D. Perkins Act, 2006).

Since 21st century skills are developed through involvement in FFA, a component of the three-circle model of agricultural education, could those skills also be attained through another component of a comprehensive, school-based agricultural education program: SAE?

2.2. Theoretical Framework

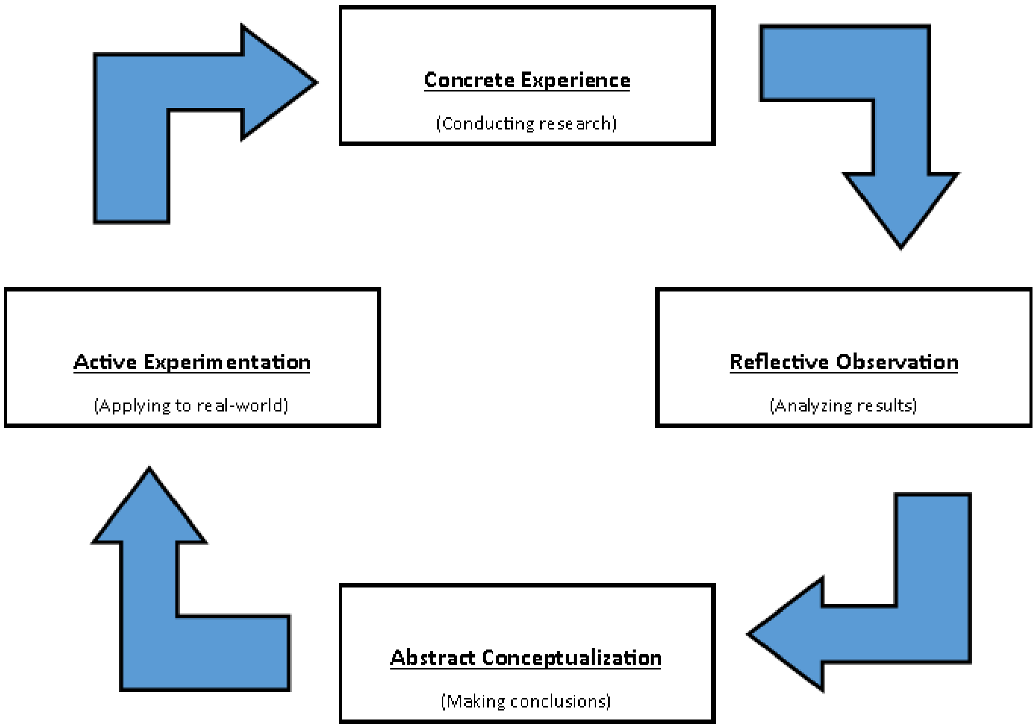


Figure 3. Agriscience research as it relates to Kolb's Experiential Learning Theory. This figure illustrates how the stages of agriscience research fit into the four-stage cycle of Kolb's Experiential Learning Theory.

Experiential learning has been a central component of agricultural education since its beginning (Cheek, Arrington, Carter, & Randell, 1994; Roberts, 2006; Stewart & Birkenholz, 1991; & Knobloch, 2003). Therefore, it was logical to utilize experiential learning theory to frame this study. According to Kolb, learning is the "process whereby knowledge is created through the transformation of experience" (1984, p. 38). Though there are many experiential learning theories, Kolb's Experiential Learning Theory best fits this study. Kolb's Experiential Learning Theory is a four-stage continuous cycle that includes 1. concrete experience, 2. reflective observation, 3. abstract conceptualization, and 4. active experimentation (Kolb, 1984). Kolb developed and published his Experiential Learning Theory in 1984 in his book *Experiential Learning: Experience as a Source of Learning and Development*. This theory asserts that as a person goes through the four cycles of experiential learning, then they will learn or create knowledge. As applied to this study, this theory holds that if a secondary student were to participate in an agriscience research SAE, which requires a student to go through the four cycles of Kolb's Experiential Learning Theory, then he or she may develop 21st century skills. This is plausible, because prior research shows that students create knowledge via experiential learning through Kolb's Experiential Learning Theory (Baker et al., 2012).

Kolb's Experiential Learning Theory should be embedded in all three components of a comprehensive, school-based agricultural education program (Baker et al., 2012). The premise of this study is based on the idea that Kolb's Experiential Learning Theory is expressed through agriscience research SAEs. Therefore, the outcome would be that 21st century skills could be learned through agriscience research SAEs. As applied to Kolb's Experiential Learning Theory, first, students identify a problem and develop a hypothesis. As they test their hypothesis, the actual experiment manifests as the concrete experience. Next, students evaluate their results, which involves them in the reflective observation stage. While reflecting, they will confirm or deny their hypothesis, evaluate sources of error, and identify discrepancies and patterns in their data. Movement into the abstract conceptualization stage would be evident as students make conclusions based upon their data. Their time in the reflective observation stage may lead them to develop new ideas and/or revise their original idea within the abstract conceptualization stage. Finally, as they apply their results and conclusions to real-world applications, the student would move into the active experimentation stage. In the case that the student starts to reinterpret their experience and develop their thoughts into new research ideas, they would move back into the concrete experience stage and begin the cycle again. This cycle could continue throughout a student's high school SAE.

Baker et al. asserts that effective experiential learning requires the purposeful support from agricultural educators (2012). An important requirement of SAE is that the project be supervised by the agricultural education instructor. It is the role of the agricultural educator to serve as facilitator as the student moves through the cycles of Kolb's Learning Theory, especially from concrete experience to reflection (Baker et al., 2012). The teacher can then serve as the content area expert as they move into the abstract conceptualization stage where they are expected to make connections to what they know and refine their ideas and hypothesis further (Baker et al., 2012). As they develop new ideas, plan new projects, and apply their findings to the real-world, the teacher will help them set goals and evaluate their progress. Finally, as they move back into the active experimentation stage, the instructor serves as a coach, guiding them back through the process once again (Baker et al., 2012). Though students may find themselves going through some of Kolb's model of experiential learning on their own, having the support of an agricultural educator guiding them through all four parts of the cycle is what truly allows them to transform their experiences into learning (Baker et al., 2012).

Within the model of Kolb's Experiential Learning Theory, the basis of this study is built on the assumption that students participating in agriscience research would attain 21st century skills through their SAE, a form of supervised experiential learning, and that they would be able to recognize the development of those skills. Because students are typically working on their own when conducting agriscience research SAEs, the 21st century skills of accountability, productivity, initiative, and self-direction are expressed through active experimentation. Within active experimentation, students build on prior knowledge and connect their learning to their personal interests, which requires creativity, innovation, and critical thinking. Within reflective observation, a student must use critical thinking and problem solving skills to reflect upon their experiment and experience. Further, as students go through abstract conceptualization and they revise their ideas, they may practice technology literacy as they seek information related to their research. Revision of their idea or the creation of new ideas from their results allows them to practice creative thinking and innovation within the abstract conceptualization stage. Changing one’s ideas may require the student to be adaptable and flexible. Finally, communication skills are developed through active experimentation in order to apply their findings to the real world. They may also express leadership and responsibly as they apply what they have discovered to the world around them. Movement back into the concrete experience also leads to adaptability skills as students work to re-test their hypothesis and act on new ideas.

3. CHAPTER THREE

3.1. Methodology

3.1.1. Purpose of the Study

The purpose of this descriptive, exploratory study was to determine if student participation in agriscience research Supervised Agricultural Experiences (SAEs) contributed to the development of selected 21st century skills, including critical thinking and problem solving, creativity and innovation, communication and collaboration, information literacy, media literacy, ICT (Information, Communications, and Technology) literacy, flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, and leadership and responsibility.

3.1.2. Research Objectives

The following research objectives guided the study:

1. Describe student involvement in agriscience research SAEs.
2. Describe student's perceptions of their current level of identified 21st century skills.
3. Describe the relationship between 21st century skills and agriscience research involvement.
4. Describe the relationship between 21st century skills and SAE involvement.
5. Compare student perceptions of their current level of identified 21st century skills between students enrolled in school based agricultural education and those not enrolled in school based agricultural education.
6. Validate an instrument used to measure self-perceived attainment of 21st century skills.

3.1.3. Research Design

This descriptive exploratory study examined the relationship between the dependent variable of 21st century skills and independent variables of involvement in agriscience SAEs, SAEs, and agricultural education, among other independent variables specific to the population. The present study employed a perceived self-efficacy survey where the high school student subjects completed a paper questionnaire to acquire their perceptions of their current attainment of 21st century skills. To appropriately account for student perceptions, a 100-point scale question structure was utilized, which is consistent with previous studies on self-perceived efficacy (Bandura, 2006).

3.1.4. Variables

The independent variables for this study were student grade level, enrollment or non-enrollment in agricultural education, and SAE type. Additional independent variables were involvement in agriscience research and the extent of their involvement in agriscience research. Data related to independent variables were collected via the demographic portion of the instrument.

The dependent variables were 21st century skills, including the constructs of creativity and innovation, critical thinking and problem solving, communication and collaboration, information literacy, media literacy, ICT (Information, Communications, and Technology) literacy, flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, and leadership and responsibility. The specific 21st century skills and their definitions were taken from the P21 Framework Definitions publication (Partnership for 21st Century Learning, 2015).

3.1.5. Subject Selection

The target population for this study consisted of 10^{th}-12^{th} grade high school students at Richland 44 High School, Kindred High School, and Glencoe-Silver Lake High School. A purposive sample was selected based on the researcher's knowledge of the agricultural education programs, prior SAE instruction, and involvement in agriscience research SAEs.

Three high schools were chosen as part of the sample group based on current involvement in SAE and agriscience research. Richland 44 High School had approximately 62 (*n*) sophomore to senior students. Kindred High School had approximately 145 (*n*) sophomore to senior students, and Glencoe-Silver Lake High School had approximately 395 (*n*) sophomore to senior students.

3.1.6. Instrumentation

The compiled instrument described herein is found in this thesis as Appendix A.

3.1.6.1. 21^{st} Century Skills

The 21^{st} Century Skills Perceived Self-Efficacy Survey was created for the purpose of this study using the guiding principles of Bandura (2006) and the P21 Framework Definitions for 21^{st} Century Skills (Partnership for 21^{st} Century Learning, 2015). The instrument was created using all eleven 21^{st} century skill categories, as defined by the Partnership for 21^{st} Century Learning (2015). The questions on the instrument were developed directly from the benchmarks and standards of each specific 21^{st} century skill category as listed in the P21 Framework Definitions. The standards and benchmarks were reworded to fit Bandura's recommended language for constructing self-efficacy scales, which required the questions to be worded in a "can do" statement in order to measure perceived capability versus self-worth (Bandura, 2006). According to Bandura, it is key that the instructions within the instrument emphasize that the questions are asking for their current level of perceived capability, rather than their intentions or future ability, in order to measure self-efficacy (2006).

Pajares, Hartley, & Valiante recommend that a response scale of 0-100 be utilized in self-efficacy instruments because the larger scale is a stronger predictor of performance than 5-interval scales (as cited in Bandura, 2006, p. 312). Smaller scales are less sensitive and reliable because people tend to avoid the extreme ends of the scale, which makes it difficult to identify any differences among subjects (Bandura, 2006).

The 21st Century Skills Perceived Self-Efficacy Survey consisted of 87 questions aimed at measuring the strength of students' efficacy beliefs related to specific 21st century skills on a 100-point scale. Three practice items were included in order for respondents to grasp the scale and concept of the instrument. The 100-point scale used descriptors at 0 (cannot do at all), 50 (moderately certain can do), and 100 (highly certain can do). Respondents were asked to indicate their current, perceived ability by writing a number between 0-100 in a column next to the statement. Eleven 21st century skill categories were included in the instrument including critical thinking and problem solving (8 questions in construct), communication and collaboration (12 questions in construct), creativity and innovation (10 questions in construct), information literacy (7 questions in construct), media literacy (7 questions in construct), ICT (information, communications, and technology) literacy (3 questions in construct), flexibility and adaptability (9 questions in construct), initiative and self-direction (8 questions in construct), social and cross-cultural skills (6 questions in construct), productivity and accountability (12 questions in construct), and leadership and responsibility (5 questions in construct).

3.1.6.2. Independent Variables (Demographics)

The final section of the instrument included 18 demographic questions and statements. Items specific to the student included: current grade, gender, enrollment in agricultural education or not, SAE involvement or not, and agriscience research involvement or not. Participants were also asked to answer questions regarding their type of SAE, years of experience in agriscience research and the number of completed projects, and involvement in FFA awards related to agriscience research, such as the agriscience fair, proficiency awards, and Star in Agriscience awards. The level of competition in FFA awards programs related to agriscience research was also collected through a series of questions. Further, questions were included to collect information about involvement in Career Development Events and involvement in chapter leadership positions. The inclusion of contextual and demographic variables was supported by previous research on SAE within agricultural education.

3.1.7. Validity Procedures

All assessment instruments were tested for face and content validity to ensure that they appeared effective and would accurately measure what they intended to measure. A panel of experts within higher education evaluated the instrument for wording and readability. Adjustments to the instrument were made, including elimination and rewording of some of the questions, based on their recommendations.

3.1.8. Reliability Procedures

The instrument was piloted with a group of 34 students similar to the identified population for this study. Students not in attendance on the day of measurement were considered non-respondents, were not followed up with, and were not included in this study. Reliability for each construct generated the following Cronbach’s alpha scores estimating the internal reliability for each construct: critical thinking and problem solving (.87), communication and collaboration (.88), creativity and innovation (.89), information literacy (.79), media literacy (.82), ICT literacy (.80), flexibility and adaptability (.83), initiative and self-direction (.85). social and cross-cultural skills (.79), productivity and accountability (.88), and leadership and responsibility (.83). In total, 20 of the questions were removed from the instrument based upon reliability analysis results. Once removed, the construct reliabilities within the instrument improved.

3.1.9. Data Collection

The 21st Century Skills Perceived Self-Efficacy Survey and demographic questions were combined into one instrument and administered to students at Richland 44 High School, Kindred High School, and Glencoe-Silver Lake High School.

Data were collected during the second semester of the school year. Data were collected from three high schools that offered comprehensive school-based agricultural education programs. The first school consisted of 62 students with 60 students participating, which achieved a 96.77 percent response rate. In the second school, 142 students were eligible with 123 students participating, which achieved an 86.62 percent response rate. The third school consisted of 395 students, with 145 participating, which achieved a 36.71 percent response rate. Total study participants included 328 students with an overall response rate of 53.16 percent.

3.1.10. Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software version 21. A response of 70-100 confidence indicated a high level of efficacy. A response of 40-69.99 indicated a moderate level of efficacy, whereas a response of 0-39.99 indicated low efficacy. The responses to all of the questions within a construct were averaged to achieve an efficacy value for the entire construct. Thus, a student's total perceived self-efficacy was reported by construct, not by each individual question.

Descriptive statistics were run to analyze independent and dependent variables, including means and standard deviations. To compare group means between those participating in either agriscience research, SAEs, or agricultural education to those who did not participate in any of those activities, independent samples *t*-tests were run with a 95% confidence level.

4. CHAPTER FOUR

4.1. Findings

4.1.1. Purpose of the Study

The purpose of this descriptive, exploratory study was to determine if student participation in agriscience research Supervised Agricultural Experiences (SAEs) contributed to the development of selected 21st century skills, including critical thinking and problem solving, creativity and innovation, communication and collaboration, information literacy, media literacy, ICT (Information, Communications, and Technology) literacy, flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, and leadership and responsibility.

4.1.2. Research Objectives

The following research objectives guided the study:

1. Describe student involvement in agriscience research SAEs.
2. Describe student's perceptions of their current level of identified 21st century skills.
3. Describe the relationship between 21st century skills and agriscience research involvement.
4. Describe the relationship between 21st century skills and SAE involvement.
5. Compare student perceptions of their current level of identified 21st century skills between students enrolled in school based agricultural education and those not enrolled in school based agricultural education.
6. Validate an instrument used to measure perceived attainment of 21st century skills.

4.1.3. Population and Sample

Questionnaires were distributed to three high schools during January, 2017. In total, 328 (*N*) students completed instruments for the study. A total of 41 questionnaires were excluded from the results of the study due to errors or response set (*N* = 287). Students unaccounted for at each school were either absent or declined to complete the instrument. Because generalizability was not the intent of this study, those potential subjects were not followed up with to supply responses. Additionally, non-response error was not calculated or considered in accordance with the design of the study. Therefore, the results of this study are not generalizable beyond the sample discussed herein.

Characteristics of the sample are found in Table 1. The greatest number of respondents were sophomores (36.9%, *n* = 106) whereas the fewest represented were juniors (27.5%, *n* = 79). The distribution of the sexes for the sample included more females (50.5%, *n* = 145) than males (47.7%, *n* = 137). A majority of respondents had enrolled in agricultural education at some point during high school (56.4%, *n* = 162) compared to respondents who had not enrolled in agricultural education before (42.2%, *n* = 121). Of the students that indicated they had a Supervised Agricultural Experience (SAE), the majority of respondents had entrepreneurship SAEs (23.9%, *n* = 27). Other SAE areas that had high participation were placement SAEs (23%, *n* = 26) and agriscience research SAEs (14.2%, *n* = 16). Fifty-four of the respondents declared having completed agriscience research projects (18.8%, *n* = 54) while a majority of students had not completed any agriscience research projects (80.5%, *n* = 231). Other demographic data related to involvement in agriscience research projects and award programs are included in Table 2.

Table 1

Demographic Characteristics of Participating Students (N = 287)

Variable	***n***	**%**
Student Class Rank		
Sophomore	106	36.9
Junior	79	27.5
Senior	95	33.1
Missing	7	2.4
Sex		
Female	145	50.5
Male	137	47.7
Other	2	0.7
Missing	3	1.0
Enrolled in Ag Ed		
Yes	162	56.4
No	121	42.2
Missing	3	1.0
SAE Type		
Entrepreneurship	27	9.4
Placement	26	9.1
Research	16	5.6
Exploratory	4	1.4
Other	24	8.4
N/A	171	59.6
Missing	3	1.0
Combined SAE	16	5.4

Table 2

Student Agriscience Involvement (N = 287)

Variable	*n*	%
Agriscience Project Participation		
Yes	54	18.8
No	107	37.3
N/A	124	43.2
Missing	2	0.7
Quantity of Agriscience Research Projects Completed		
Zero	1	0.3
One	27	9.4
Two	16	5.6
More than two	10	3.4
N/A	232	80.8
Missing	1	0.3
Length of Involvement in Agriscience Research Projects		
Less than one year	24	8.4
One year	15	5.2
More than one year	14	4.8
N/A	232	80.8
Missing	2	0.7
Involvement in Agriscience Fair		
Yes	38	13.2
No	17	5.9
N/A	232	80.8
Level of Involvement in Agriscience Fair		
Local	17	5.9
District/Area/Regional	2	0.7
State	1	0.3
N/A	248	86.4
Multiple Levels	19	6.5

4.1.4. Research Objective Two

Research objective two was to describe student's perceptions of their current level of identified 21st century skills. Respondents were asked to rate their confidence in their ability to accomplish various tasks related to 21st century skills. Students reported their perceived self-efficacy of 21st century skills using a 100-point scale. The 100-point scale used descriptors at 0 (cannot do at all), 50 (moderately certain can do), and 100 (highly certain can do). Respondents were asked to indicate their current, perceived ability to complete a task by writing a number between 0-100 in a column next to the statement. Each subject's perceived self-efficacy was measured using eleven different constructs of 21st century skills, including critical thinking and problem solving (8 questions in construct), communication and collaboration (12 questions in construct), creativity and innovation (10 questions in construct), information literacy (7 questions in construct), media literacy (7 questions in construct), ICT (information, communications, and technology) literacy (3 questions in construct), flexibility and adaptability (9 questions in construct), initiative and self-direction (8 questions in construct), social and cross-cultural skills (6 questions in construct), productivity and accountability (12 questions in construct), and leadership and responsibility (5 questions in construct). Descriptive statistics for the entire sample population were reported in Table 3.

The sample means for each 21st century skill construct indicate respondents, on average, reported a high confidence in their abilities within each skill area. An average response of 70-100 indicated a high level of perceived self-efficacy. A response mean of 40-69.99 indicated a moderate level of efficacy, whereas a mean of 0-39.99 indicated low efficacy. The means for each 21st century skill construct fell within a high level of perceived self-efficacy, with the lowest mean being the communication and collaboration construct (M = 72.19, SD = 15.54) to the highest mean being ICT literacy (*M* = 80.11, SD = 14.09) for the entire present sample (*N* = 287).

Table 3

Student Perceived Self-Efficacy of 21st Century Skill Constructs (*N* = 287).

			Range	
21st Century Skill Construct	***M***	***SD***	**Min**	**Max**
Critical Thinking and Problem Solving	75.76	14.93	15	100
Communication and Collaboration	72.19	15.54	13.33	100
Creativity and Innovation	74.02	14.81	13	100
Information Literacy	73.31	15.51	12.86	100
Media Literacy	73.42	15.85	17.14	100
ICT Literacy	80.11	17.07	10	100
Flexibility and Adaptability	73.65	14.72	15.56	100
Initiative and Self-direction	77.04	15.27	8.75	100
Productivity and Accountability	78.72	14.76	11.67	100
Leadership and Responsibility	73.20	17.34	4.0	100
Social and Cross-cultural Skills	78.17	14.09	13.33	100

Note. Perceived self-efficacy used a 100 point scale using descriptors at 0 (cannot do at all), 50 (moderately certain can do), and 100 (highly certain can do). Range based off of averaged construct means.

4.1.5. Research Objective Three

Research objective three was to describe the relationship between 21st century skills and agriscience research involvement. The researcher asked respondents to report whether or not they had participated in agriscience research projects. Table 4 displays the results of students' perceived self-efficacy of the 21st century skills constructs based on those who had completed agriscience research projects and those that have not participated in agriscience research projects. The majority of students (81.1%, $n = 231$) had not completed an agriscience research project and 18.9% ($n = 54$) students reported having completed an agriscience research project.

Using Levene's test for equality of variances, equal variances were assumed ($p > .05$) for all 21st century skill constructs. Students who reported having completed agriscience research projects had higher means of perceived self-efficacy in all of the 21st century skill constructs except ICT literacy and social and cross-cultural skills, as compared to those who did not report completing an agriscience research project. However, according to the independent samples *t*-test, none of the differences in the group means were statistically significant ($p > .05$) for any of the constructs. Therefore, within the present sample agriscience research projects did not have a statistically significant influence upon student's perceptions of their 21st century skill abilities.

Table 4

Perceived Self-Efficacy of 21st Century Skill Constructs for Students With and Without Agriscience Research Projects (N = 285)

	n	***M^a^***	***SD***	***SE***	***t***	***df***	**Sig. (2-tailed)**
Critical Thinking/Problem Solving					-0.74	283	.457
Agriscience research	54	77.07	12.96	1.76			
No agriscience research	231	75.39	15.41	1.01			
Communication/Collaboration					-1.18	283	.237
Agriscience research	54	74.39	13.30	1.81			
No agriscience research	231	71.60	16.05	1.06			
Creativity/Innovation					-1.05	283	.295
Agriscience research	54	75.88	11.93	1.62			
No agriscience research	231	73.52	15.42	1.01			
Information Literacy					-1.20	283	.232
Agriscience research	54	75.56	12.55	1.71			
No agriscience research	231	72.74	16.13	1.06			
Media Literacy					-1.01	283	.314
Agriscience research	54	75.34	13.64	1.86			
No agriscience research	231	72.92	16.36	1.08			
ICT Literacy					0.31	283	.755
Agriscience research	54	79.41	15.41	2.10			
No agriscience research	231	80.22	17.47	1.15			
Flexibility/Adaptability					-0.82	283	.413
Agriscience research	54	75.05	13.55	1.84			
No agriscience research	231	73.23	15.01	0.99			
Initiative/Self Direction					-1.43	283	.154
Agriscience research	54	79.69	13.52	1.84			
No agriscience research	231	76.39	15.64	1.03			
Productivity/Accountability					-0.71	283	.479
Agriscience research	54	79.98	13.31	1.81			
No agriscience research	231	78.39	15.13	1.00			
Leadership/Responsibility					-0.78	283	.435
Agriscience research	54	74.80	16.83	2.29			
No agriscience research	231	72.75	17.53	1.15			
Social and Cross-cultural Skills					0.34	283	.735
Agriscience research	54	77.53	12.43	1.69			
No agriscience research	231	78.26	14.51	0.95			

Note[a]. 21st century skill constructs used a 100-point scale using descriptors at 0 (cannot do at all), 50 (moderately certain can do), and 100 (highly certain can do).

4.1.6. Research Objective Four

Research objective four was to describe the relationship between 21st century skills and SAE involvement. Students were asked to report whether or not they had an SAE. Table 5 displays the results of students' perceived self-efficacy of the 21st century skills constructs based on those with SAEs and those that did not have SAEs. The majority of students (59.6%, $n = 171$) did not have an SAE compared to those students who reported having an SAE (39.4%, $n = 113$).

Equal variances were assumed for all 21st century skill constructs due to Levene's test for equality of variances ($p > .05$). Students who reported involvement in SAEs recorded higher means of perceived self-efficacy in all of the 21st century skill constructs, as compared to students who were not involved in SAEs. However, none of the differences in the means between the groups were statistically significant based on the results of the independent samples *t*-test. Thus, student engagement in SAEs did not have a statistically significant impact upon student's perceptions of their 21st century skill abilities within the current sample.

Table 5

Perceived Self-Efficacy of 21st Century Skill Constructs for Students With and Without SAEs (N = 285)

	n	M^a	SD	SE	t	df	Sig. (2-tailed)
Critical Thinking/Problem Solving					-0.26	283	.784
SAE	113	76.01	13.42	1.26			
No SAE	172	75.51	15.94	1.22			
Communication/Collaboration					-1.36	283	.175
SAE	113	73.68	13.72	1.29			
No SAE	172	71.12	16.66	1.27			
Creativity/Innovation					-1.08	283	.280
SAE	113	75.14	12.44	1.17			
No SAE	172	73.20	16.20	1.24			
Information Literacy					-1.95	283	.052
SAE	113	75.48	12.72	1.97			
No SAE	172	71.83	17.01	1.30			
Media Literacy					-0.81	283	.417
SAE	113	74.32	14.61	1.37			
No SAE	172	72.76	16.68	1.27			
ICT Literacy					-0.18	283	.854
SAE	113	80.30	15.57	1.46			
No SAE	172	79.92	18.05	1.38			
Flexibility/Adaptability					-1.04	283	.299
SAE	113	74.69	13.49	1.27			
No SAE	172	72.84	15.50	1.18			
Initiative/Self Direction					-0.80	283	.442
SAE	113	77.91	14.16	1.33			
No SAE	172	76.42	16.01	1.22			
Productivity/Accountability					-1.18	283	.240
SAE	113	79.97	12.31	1.16			
No SAE	172	77.86	16.21	1.24			
Leadership/Responsibility					-1.37	283	.171
SAE	113	74.88	15.55	1.46			
No SAE	172	71.99	18.45	1.41			
Social and Cross-cultural Skills					-0.56	283	.574
SAE	113	78.70	12.17	1.14			
No SAE	172	77.74	15.29	1.17			

Note[a]. 21st century skill constructs used a 100-point scale using descriptors at 0 (cannot do at all), 50 (moderately certain can do), and 100 (highly certain can do).

4.1.7. Research Objective Five

Research objective five was to compare student perceptions of their current level of identified 21st century skills between students enrolled in school-based agricultural education and those not enrolled in school-based agricultural education. Respondents were asked to report whether or not they had enrolled in school-based agricultural education courses. Table 6 displays the results of students' perceived self-efficacy of the 21st century skills constructs based on those who had enrolled in school-based agricultural education and those who had not enrolled in school-based agricultural education. The majority of students (56.4%, $n = 162$) had enrolled in an agricultural education course compared to those students that reported that they had not enrolled in an agricultural education course before (42.2%, $n = 121$).

Equal variances were assumed for all 21st century skill constructs because of the Levene's test for equality of variances ($p > .05$). Students that were enrolled in agricultural education courses reported higher means of perceived self-efficacy in all of the 21st century skill constructs except ICT literacy, when compared to those students that were not enrolled in agricultural education. However, the group means for each construct were not statistically significantly different between the two sample groups ($p > .05$) as indicated by the results of the independent samples *t*-test results. Consequently, enrollment in agricultural education did not have a statistically significant effect on the perceived self-efficacy of 21st century skill attainment within the existing sample.

Table 6

Perceived Self-Efficacy of 21st Century Skill Constructs Based on Enrollment in SBAE (*N* = 283)

	n	***M*[a]**	***SD***	***SE***	***t***	***df***	**Sig.(2-tailed)**
Critical Thinking/Problem Solving					-0.40	281	.693
Enrolled in Ag Ed	121	76.03	13.77	1.08			
Not enrolled in Ag Ed	162	75.32	16.56	1.51			
Communication/Collaboration					-0.48	281	.628
Enrolled in Ag Ed	121	72.61	14.47	1.14			
Not enrolled in Ag Ed	162	71.70	17.06	1.55			
Creativity/Innovation					-0.72	281	.473
Enrolled in Ag Ed	121	74.63	13.60	1.07			
Not enrolled in Ag Ed	162	73.34	16.45	1.50			
Information Literacy					-0.90	281	.370
Enrolled in Ag Ed	121	74.09	14.15	1.11			
Not enrolled in Ag Ed	162	72.41	17.21	1.56			
Media Literacy					-0.67	281	.503
Enrolled in Ag Ed	121	73.93	15.10	1.19			
Not enrolled in Ag Ed	162	72.65	16.94	1.54			
ICT Literacy					0.50	281	.619
Enrolled in Ag Ed	121	79.64	16.79	1.32			
Not enrolled in Ag Ed	162	80.67	17.53	1.59			
Flexibility/Adaptability					-0.54	281	.588
Enrolled in Ag Ed	121	74.03	14.24	1.12			
Not enrolled in Ag Ed	162	73.07	15.49	1.41			
Initiative/Self Direction					-0.62	281	.536
Enrolled in Ag Ed	121	77.50	14.45	1.14			
Not enrolled in Ag Ed	162	76.36	16.48	1.50			
Productivity/Accountability					-0.74	281	.460
Enrolled in Ag Ed	121	79.25	13.43	1.06			
Not enrolled in Ag Ed	162	77.92	16.55	1.50			
Leadership/Responsibility					-0.35	281	.731
Enrolled in Ag Ed	121	73.51	16.30	1.28			
Not enrolled in Ag Ed	162	72.79	18.84	1.71			
Social and Cross-cultural Skills					-0.24	281	.810
Enrolled in Ag Ed	121	78.29	12.79	1.00			
Not enrolled in Ag Ed	162	77.88	15.73	1.43			

Note[a]. 21st century skill constructs used a 100-point scale using descriptors at 0 (cannot do at all), 50 (moderately certain can do), and 100 (highly certain can do).

4.1.8. Research Objective Six

Research objective six was to validate an instrument used to measure perceived self-efficacy of 21st century skill attainment. Post-hoc reliability tests were operationalized to measure the alpha score for each construct. The resulting Cronbach's α scores for each 21st century skill construct are reported in Table 7.

Table 7

Post-hoc Reliability Analysis of 21st Century Skills Instrument

Construct	**Cronbach's α**	**Items (*n*)**
Critical Thinking/Problem Solving	0.88	8
Communication/Collaboration	0.92	12
Creativity/Innovation	0.91	10
Information Literacy	0.87	7
Media Literacy	0.86	7
ICT Literacy	0.76	3
Flexibility/Adaptability	0.87	9
Initiative/Self Direction	0.87	8
Social/Cross-cultural Skills	0.79	6
Productivity/Accountability	0.92	12
Leadership/Responsibility	0.83	5

5. CHAPTER FIVE

5.1. Conclusions, Implications, and Recommendations

5.1.1. Purpose of the Study

The purpose of this descriptive, exploratory study was to determine if student participation in agriscience research Supervised Agricultural Experiences (SAEs) contributed to the development of selected 21st century skills, including critical thinking and problem solving, creativity and innovation, communication and collaboration, information literacy, media literacy, ICT (Information, Communications, and Technology) literacy, flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, and leadership and responsibility.

5.1.2. Research Objectives

The following research objectives guided the study:

1. Describe student involvement in agriscience research SAEs.
2. Describe student's perceptions of their current level of identified 21st century skills.
3. Describe the relationship between 21st century skills and agriscience research involvement.
4. Describe the relationship between 21st century skills and SAE involvement.
5. Compare student perceptions of their current level of identified 21st century skills between students enrolled in school based agricultural education and those not enrolled in school based agricultural education.
6. Validate an instrument used to measure perceived attainment of 21st century skills.

5.1.3. Conclusions

There has been a nationwide decline of SAE involvement within school-based agricultural education (Dyer & Osborne, 1995; Steele, 1997; Retallick & Martin, 2008), however, agricultural education instructors agree that SAE should continue to be an integral part of the agricultural education model (Camp et al., 2000; Wilson & Moore, 2007). Further, empirical evidence supports the benefits of SAE (Cheek et al., 1994; Dyer & Williams, 1997; Ramsey & Edwards, 2012; Stewart & Birkenholz, 1991; Talbert et al., 2007).

Compared to traditional SAE areas, such as entrepreneurship, which have seen a decrease of 0.54% per year in some states (Retallick & Martin, 2008), agriscience research SAEs are growing in popularity. In select states, like Iowa, involvement in agriscience research SAEs is increasing at a rate of 14.27% per year (Retallick & Martin, 2008). Could the use of agriscience research SAEs be a way to meet the needs of the growing and changing student population within school-based agricultural education?

Kolb's Experiential Learning Theory provided the framework for this study. According to Kolb, learning is the "process whereby knowledge is created through the transformation of experience" (1984, p. 38). Applied to this study, this theory holds that if a high school agricultural education student were to engage in agriscience research, which requires a student to go through the four cycles of Kolb's Experiential Learning Theory, then they may develop 21st century skills. This is because experimental agriscience research aligns closely with inquiry based teaching methods, which according to prior research, leads to the attainment of 21st century skills, such as critical thinking and communication skills (Haury, 1993; Thoron & Myers, 2012; Mabie & Baker, 1996).

Among the schools sampled for this study, agriscience research is being utilized by students as an SAE area and as an experiential learning activity through agriscience research activities. Of the 287 respondents, 54 indicated they had participated in agriscience research and 16 confirmed they maintained agriscience research SAEs. Though there were fewer students who participated in agriscience research SAE (n = 16, 14.2%) than more traditional SAE areas, such as entrepreneurship (n = 27, 23.9%) and placement (n = 26, 23%), it was still the third most popular SAE area.

When comparing groups of students within school-based agricultural education to those students outside of agricultural education, this study found an increase in perceived self-efficacy of the 21st century skill constructs for students that were involved in agricultural education, maintained SAEs, and participated in agriscience research, compared to those students that did not. Though not statistically significant, the research does indicate that involvement in school-based agricultural education, SAE, and agriscience research may lead to higher levels of perceived 21st century skill attainment. Therefore, participation in experiential learning-based activities, which manifests as activities within school-based agricultural education, SAE, and agriscience research, students do attain 21st century skills by moving through the four-stage cycle of Kolb's Experiential Learning Theory.

5.1.3.1. Research Objective One

Of the students that reported having an SAE, 14.2% indicated they had agriscience research SAEs (n = 16). Though entrepreneurship SAEs (23.9%, n = 27) and placement SAEs (23%, n = 26) were more common SAE areas among the subjects, agriscience research SAEs were the third most commonly utilized SAE area. Granted, the population was purposely-selected based on agriscience research involvement, the data do indicate that agriscience research SAEs are being utilized by select school-based agricultural education programs in North Dakota and Minnesota.

Interestingly, there were students that claimed participation in agriscience research projects (n = 54) but did not indicate participation in an agriscience research SAE (n = 16) and vice versa; students indicated participation in agriscience research SAEs without agriscience research projects. This raised a question regarding whether or not students fully understood the definition of what an agriscience research SAE was or what an agriscience research project entails. For the purpose of this study, focus was placed on experimental agriscience research SAEs, though, according to the National Council for Agricultural Education (2015), students engaged in agriscience research SAEs do not have to participate in experimental agriscience research projects. Agriscience research SAEs can entail analytical and invention projects instead of experimental research (National Council for Agricultural Education, 2015). Defining an agriscience research project is much more difficult, as the definitions that currently exist are broad and not consistent among all school-based agricultural education programs. For example, definitions range from agriscience research projects conducted for the purpose of competing in the National Agriscience Fair (National FFA, 2017) to the integration of science into the agricultural education classroom (Phipps et al., 2008).

5.1.3.2. Research Objective Two

In general, students had higher than expected means of perceived self-efficacy regarding their 21st century skill attainment. For the purpose of this study, an average response mean (*M*) of 70-100 confidence indicated a high level of efficacy. A response of 40-69.99 indicated a moderate level of efficacy, whereas a response of 0-39.99 indicated low efficacy. The subjects in this study rated themselves with a high level of efficacy in all eleven of the constructs, achieving means greater than 70 on the confidence scale.

As an entire group, the high school age subjects had the highest level of perceived self-efficacy in the ICT (information, communication, and technology) literacy construct (*M* = 80.11, SD = 17.02), meaning, as a whole, the students sampled felt highly confident in their ability to utilize technology for various tasks. Other constructs that were rated with high levels of perceived self-efficacy were productivity and accountability (*M* = 78.72, SD = 14.76), social and cross-cultural skills (*M* =78.17, SD = 14.09), initiative and self-direction (*M* = 77.04, SD = 15.27), critical thinking and problem solving (*M* = 75.76, SD = 14.93), and creativity and innovation (*M*= 74.02, SD = 14.81). The lowest ranking construct was communication and collaboration (*M*= 72.19, SD = 15.54), though it still indicated a high level of group confidence in their perceived self-efficacy. Other lower ranking constructs, that were still considered highly confident, were leadership and responsibility (*M*= 73.20, SD = 17.34), information literacy (*M*= 73.31, SD = 15.51), media literacy (*M*= 73.42, SD = 15.85), and flexibility and adaptability (*M*=73.65, SD =14.72).

As a whole, the sample group indicated they had a high level of perceived self-efficacy as it relates to all eleven of the 21st century skills. Unfortunately, the high levels of perceived self-efficacy made it challenging to compare means among independent variables because a majority of students experienced high levels of confidence in their ability to complete tasks related to 21st century skills regardless of whether they were involved in agricultural education or not.

5.1.3.3. Research Objective Three

On average, students who participated in agriscience research projects reported higher means of perceived self-efficacy within all of the 21st century skill constructs except ICT literacy and social and cross-cultural skills. Students that participated in agriscience research reporter higher perceived self-efficacy in the initiative and self-direction construct (*M* = 79.69, SD = 13.52) compared to students that had not participated (*M* = 76.39, SD = 15.64). Other constructs where students who had participated in agriscience research reported higher perceived self-efficacy than their peers that had not participated included; information literacy (*M* = 75.56, SD

= 12.55) compared to (*M* = 72.74, SD = 16.13) and communication and collaboration (74.39, SD = 13.30) compared to (*M* = 71.60, SD = 16.05).

Unfortunately, none of the results were statistically significant based on the independent samples *t*-test. Nonetheless, the results do support prior research (Haury, 1993). Because experimental agriscience research projects include the same components as inquiry-based education (National Council for Agricultural Education, 2015; National Research Council, 2000), it was proposed that student engagement in agriscience research projects may lead to the same outcomes as inquiry-based teaching. Haury (1993) concluded that inquiry-based teaching led to the outcomes of improved scientific literacy, critical thinking, and communication skills. The outcomes of this study support the findings of Haury (1993) as information literacy and communication skills showed the greater means in perceived self-efficacy in students that had completed agriscience research projects compared to those that had not.

It was surprising that critical thinking and problem solving did not receive higher scores of perceived self-efficacy among students that had completed agriscience research projects compared to students that had not completed projects. However, it is possible that because schools are placing a high emphasis on critical thinking, students felt confident in their ability to complete critical thinking and problem solving tasks regardless of whether they had completed research projects or not.

Ultimately, the results of this study do indicate that students who are involved in agriscience research perceive higher levels of 21st century skill attainment than their peers. The purpose of this research study was to determine if involvement in agriscience research contributed to the development of 21st century skills. Though not significant based on the independent samples *t*-test, the results do support the idea that agriscience research does lead to the development of 21^{st} century skills.

<u>5.1.3.4. Research Objective Four</u>

When comparing students with SAEs to those students without SAEs, the students with SAEs reported higher means of perceived self-efficacy in all eleven of the 21^{st} century skill constructs. Though not statistically significant, students that had maintained SAEs did perceive higher levels of 21^{st} century skill attainment, which does further highlight the value of SAE as it relates to the three-circle model within school-based agricultural education programs. Kolb's Experiential Learning Theory states that learning is the "process whereby knowledge is created through the transformation of experience" (1984, p. 38). Since SAEs are a form of experiential learning, within the framework of Kolb, it does fit that students would attain 21^{st} century skills by participation in SAEs.

Further, in a time when SAE numbers are continuing to decrease (Dyer & Osborne, 1995; Steele, 1997; Retallick & Martin, 2008; Croom, 2008), the results of this study argue the value of SAE as the data indicate that students who participate in SAE achieve higher levels of perceived 21^{st} century skill attainment.

<u>5.1.3.5. Research Objective Five</u>

In a comparison between students who had enrolled in agricultural education and those who had not enrolled in agricultural education, it was found that students who had enrolled in agricultural education had higher means of perceived self-efficacy in all 21^{st} century skill constructs except ICT literacy. Even though experiential learning is usually used to describe SAE involvement within agricultural education, it is implemented throughout all three circles of the agricultural education model (Knobloch, 2003; Baker et al., 2012; Roberts, 2006). Therefore, it follows the same logic that if 21st century skills can be learned through SAE as a form of experiential learning, then students are also able to develop 21st century skills through agricultural education as a whole.

Though the connection between 21st century skill attainment and enrollment in agricultural education is not statistically significant, still, students enrolled in agricultural education did report higher means of perceived self-efficacy on average, than their peers that had not enrolled in school-based agricultural education.

5.1.4. Discussion/Recommendations/Implications for Practice

Though statistical significance was not achieved in this study, the results of this study are still relevant for practice within school-based agricultural education. It has been challenging for SAE to keep up with the trends and changes in agricultural education (Camp et al., 2000). The majority of agricultural education students do not live on farms and are no longer coming from traditional farming backgrounds (Phipps et al., 2008). The utilization of agriscience research SAEs may be one way to engage students from less traditional demographics and meet the needs and demands of students that will be pursuing agricultural careers in the new century (Camp et al., 2000).

Though the results are not generalizable across the entire population of agricultural education students in the country, the research does highlight the potential value of integrating agriscience research projects and agriscience research SAEs within school-based agricultural education programs. Since teachers do agree that SAE should remain an integral part of the three-circle model of agricultural education (Camp et al., 2000; Wilson & Moore, 2007) this study does support the value of agriscience research as an SAE area and potentially provides an avenue for teachers to offer another option for SAE involvement.

More research needs to be developed regarding agriscience research SAEs and their application within school-based agricultural education. However, this study begins to place quantifiable value upon agriscience research SAEs. Some instructors may be hesitant to utilize agriscience research as an SAE area for their students because it is a non-traditional SAE and lacks the history of entrepreneurship or placement SAEs. Yet, agriscience research SAEs still utilize the four-stage cycle of Kolb's Theory of Experiential Learning to initiate learning. Just like other methods of experiential learning, students learn through conducting research (1. concrete experience), analyzing results (2. reflective observation), making conclusions (3. abstract conceptualization), and applying their findings to the real-world (4. active experimentation). In order to achieve learning outcomes, it is important for agricultural educators to help students move through all four stages of Kolb's Theory of Experiential Learning, regardless of what SAE area they are working in.

National FFA has supported agriscience research SAEs by encouraging and supporting the growth of the agriscience fair and agriscience proficiency award areas, which highlight student agriscience research projects and agriscience research SAEs. Because of the separation between the agriscience fair and agriscience research SAEs, there appears to be some confusion as to what student activities fall into each category. The study showed some overlap between agriscience research SAEs (n = 16) and agriscience research projects (n= 54), but not nearly as much overlap as the researcher expected. The difference between the number of students that conducted projects and the number of students that said they were involved in agriscience research SAEs, indicates that perhaps students are engaged in agriscience research projects without fully engaging in an agriscience research SAE. It is possible that students felt that agriscience research conducted during class time qualified as a project, but did not meet the requirements for an agriscience research SAE. On the other hand, one can conduct agriscience research as part of an SAE or a class and not participate in the agriscience fair. Further, because agriscience research SAEs are relatively new and the agriscience fair is growing in popularity, it is likely that many agricultural educators do not know the difference between agriscience research and agriscience research SAEs. A standard definition that can be utilized by all agricultural education programs would be helpful when defining student projects within FFA for participation in the agriscience fair or proficiency awards.

The lack of a common definition for agriscience research SAEs and agriscience research likely led to inconsistencies in the reported data of this study. The confusion further emphasizes the need for a clear and consistent definition of what an agriscience research SAE or agriscience research project is. Creating a clear definition that is consistent among teacher education programs across the country will be essential to the successful implementation of agriscience research projects and SAE within school-based agricultural education in the future. Further, successful implementation of agriscience research SAEs and projects will almost always begin with the agricultural education teacher. Ensuring that pre-service teachers understand the potential value of SAE, specifically agriscience SAEs, is left to the responsibility of teacher education programs. If it is agreed that SAE is still a valuable component of the three-circle model of agricultural education, then providing teachers with research-based tools will be essential to the successful utilization of SAE in the future. In some situations, the utilization of agriscience research SAEs may be a tool that some teachers find useful within their own programs. Therefore, it is important for our pre-service teachers to understand all of their potential SAE options, including agriscience research SAEs.

According to the National Quality Program Standards (National Council for Agricultural Education (2016), 100 percent of students enrolled in agricultural education are expected to maintain an SAE. It is sometimes difficult to find suitable options for all students, especially when they may not have agriculture backgrounds or potential job opportunities. Agriscience research is suitable for many students because the categories are diverse and the inputs required are minimal beyond what a high school would already have on hand. Teachers looking to integrate agriscience research as an SAE are in their schools could collaborate with their science teachers. Further, efforts should be made by experienced agricultural educators that have implemented agriscience research SAEs into their programs to share best practices with other teachers in the profession.

Additionally, this research does begin to provide some quantifiable data to the value of agriscience fair and agriscience research proficiency awards. Because of the positive outcomes engagement in agriscience research had on the attainment of 21^{st} century skills, the National FFA Organization should to continue to promote the growth of these events through continued sponsorship, as well as encouraging more participation from all states and chapters. Therefore, more students can experience the positive outcomes due to involvement in agriscience research.

5.1.5. Discussion/Recommendations/Implications for Research

The data collected from this research indicate that school-based agricultural education, SAE, and agriscience research can play a role in the attainment of 21^{st} century skills. However, the results were not significant; thus, further research should be developed and conducted. There should be more research conducted regarding the relationship between agriscience research and potential outcomes from student participation, especially as those outcomes relate to 21^{st} century skills.

First, this study utilized a purposive sample, which prevents the results from being generalizable across the entire population of agricultural education. Using a random sample of students enrolled in agricultural education may lead to results with more statistical significance. As engagement in agriscience research increases, hopefully, there will be enough students involved in agriscience activities to achieve results from a random sample. A purposive sample was selected for this study because of the limited utilization of agriscience research as an SAE area within North Dakota and Minnesota.

Though the instrument was tested for validity and reliability prior to its utilization within this study, there is room for improvement. As mentioned, a clear and consistent definition needs to be developed for what constitutes an agriscience research SAE and what qualifies as an agriscience research project. Once those definitions are created, they should be included in the demographics section of the instrument to better define student experiences that may lead to differences in perceived self-efficacy of 21st century skills.

Though Bandura (2006) recommended the use of a 0-100 point scale when measuring perceived self-efficacy, the researcher noticed few instances where students moved away from whole numbers (i.e. 50, 60, 80, etc.). Perhaps, the larger numbers played a role in student fatigue. Further, it is possible that students viewed the 100-point scale with a negative connotation because of the 100-point grading scale most students are evaluated with in schools. In that instance, a perceived self-efficacy of 70 would be equivalent to a C or D. Studying the size of the scale used within the perceived self-efficacy of 21st century skills instrument would be an interesting topic of research.

It is possible that the instrument used to collect information was too long, as some surveys were rejected due to response set and incompleteness. Moving forward, future research could include fewer of the 21st century skill constructs. Since there was little difference between groups concerning ICT literacy and social and cross-cultural skills, perhaps those constructs could be removed from the instrument during future studies.

Though perceived self-efficacy suited the purpose of this study, is it the best method to collect information regarding 21st century skill attainment? Perceived self-efficacy was chosen because there were no current instruments available to measure all of the 21st century skill constructs at once. However, do students' perceptions of their ability accurately measure their actual attainment of specific skills? This question does highlight the need for further research, specifically regarding the actual attainment of identified skills, not just student perceptions of skills.

In the future, research regarding 21st century skills could be conducted on a per construct basis. For example, there are current, research-based instruments that can be used to measure critical thinking skills or communication skills. There may be other instruments suitable to measure other 21st century skills constructs. The perceived self-efficacy of 21st century skills instrument was developed because the researcher wanted to develop an instrument that could measure all of the 21st century skills together, though that may not be necessary in future research studies.

A unexpected problem that arose from using perceived self-efficacy was that the average means among the entire population sampled for all eleven of the 21st century skill constructs were defined as high levels of perceived self-efficacy ($M > 70$). This made comparisons between groups of students challenging and less significant because the perceived self-efficacy was high for the majority of the students, making differences between groups difficult to identify. It would be valuable to find a way to measure the differences between groups of students with more accuracy than perceived self-efficacy. Future research could focus on quantitative science outcomes, such as ACT score or state science assessment data. Though not related to 21st century skills, being able to identify the attainment of specific science skills would still provide a communicable value to the implementation of agriscience research SAE and agriscience research projects within school-based agricultural education.

A study could be conducted using a quasi-experimental design to measure the change in perceived self-efficacy or the attainment of specific skills before and after conducting agriscience research projects. There are challenges associated with this type of research due to various threats to internal validity; however, it could provide some insight into the effect that agriscience research participation has on the change in perceived self-efficacy over time of the student participants.

Curriculum for Agricultural Science Education (CASE) is an agricultural education curriculum that is designed using inquiry-based teaching methods. It has been growing in popularity across the country. Because both agriscience research and CASE lesson utilize inquiry-based teaching methods, it would be interesting to determine if the CASE curriculum and teaching method would have an effect on 21st century skill perceptions or attainment.

A qualitative research study could be conducted using students that have different levels of experience in agriscience research and agriscience research SAEs. It would be interesting to interview students competing in the agriscience fair at the local, state, and national level. The advantage of interviewing students is that it requires students to reflect upon their attainment of 21st century skills. The act of reflection is an integral component of Kolb's Theory of Experiential Learning, which may benefit the acquisition of 21st century skills.

Additionally, teachers could be interviewed or surveyed to determine what they are currently doing to encourage students to recognize and reflect upon their development of 21st century skills. According to Osborne (1994), agricultural educators rarely provide opportunities for active experimentation or internal reflection while utilizing experiential learning experiences, such as SAE. Since all steps of Kolb's Theory of Experiential Learning are essential to acquire skills, it would be interesting to study what teachers are doing to get students to reflect upon their experiences that may lead to the development of 21st century skills.

The overarching purpose of this research study was to determine if involvement in agriscience research SAEs would lead to the attainment of 21st century skills. However, specific objectives of the study focused on the relationship between SAE and 21st century skill attainment. Prior research indicates SAE is in decline and challenging to incorporate into the three-circle model of agricultural education. Research must be conducted to realize the value of SAE in today's model of agricultural education. This study demonstrates that there is value in students maintaining SAEs. Further research should be conducted to measure the positive outcomes of engagement in SAE.

REFERENCES

Baker, M. A., Robinson, J. S, & Kolb, D. A. (2012). Aligning Kolb's experiential learning theory with a comprehensive agricultural education model. *Journal of Agricultural Education, 53*(4), 1-16. doi: 10.5032/jae.2012.04001

Bandura, A. (2006). Guide for constructing self-efficacy scales. In T. Urdan & F. Pajares (Eds), *Self-efficacy beliefs of adolescents* (307-337). Greenwhich, Connecticut: Information Age Publishing.

Bird, W. A., Martin, M. J., & Simonsen, J. C. (2013). Student motivation for involvement in supervised agricultural experiences: An historical perspective. *Journal of Agricultural Education, 54*(1), 31-46. doi: 10.5032/jae.2013.01031

Caulfield, J. (2011). *How to design and teach a hybrid course*. Sterling, VA: Stylus Publishing, LLC.

Camp, W. G., Clarke, A., Fallon, M. (2000). Revisiting supervised agricultural experience. *Journal of Agricultural Education, 41*(3), 13-22. doi: 10.5032/jae.2000.03013

Carl D. Perkins Career and Technical Education Improvement Act. (2006) 20, U.S.C. § 2301.

Casner-Lotto, J., & Barrington, L. (2006) *Are they really ready to work? Employers' perspectives on the basic knowledge and applied skills of new entrants to the 21st century U.S. workforce.* Retrieved from http://www.p21.org/storage/documents/ FINAL_REPORT_PDF09-29-06.pdf

Cheek, J. G., Arrington, L. R., Carter, S., & Randell, R. S. (1994). Relationship of supervised agricultural experience program participation and student achievement in agricultural education. *Journal of Agricultural Education, 35*(2), 1-5. doi: 10.5032/jae.1994.02001

Clark, R. W., Threeton, M. D., & Ewing, J. C. (2010). The potential of experiential learning models and practices in career and technical education & career and technical teacher education. *Journal of Career and Technical Education, 25*(2), 46-62. Retrieved from https://ejournals.lib.vt.edu/index.php/JCTE/article/view/501/476

Croom, D. B. (2008). The development of the integrated three-component model of agricultural education. *Journal of Agricultural Education, 49*(1), 110-120. doi: 10.5032/jae.2008.01110

Dyer, J. E., & Osborne, E.W. (1995). Participation in supervised agricultural experience programs: A synthesis of research. *Journal of Agricultural Education, 36*(1), 6-14. doi: 10.5032/jae.1995.01006

Dyer, J. E., & Williams, D. L. (1997). Benefits of supervised agricultural experience programs: A synthesis of research. *Journal of Agricultural Education, 38*(4), 50-58. doi: 10.5032/jae.1997.04050

Haury, D. L. (1993). Teaching science through inquiry. *ERIC/CSMEE Digest*. Retrieved from http://www.ericdigests.org/1993/inquiry.htm

Knobloch, N. A. (2003). Is experiential learning authentic? *Journal of Agricultural Education, 44*(4), 22-34. doi: 10.5032/jae.2003.04022

Kohn, C. (2014). SAEs for a suburban agriscience program. *The Agricultural Education Magazine, 86*(6), 17-18.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development.* Englewood Cliffs, NJ: Prentice Hall.

Lewis, L. J., Rayfield, J., & Moore, L. L. (2012) Supervised agricultural experience: An examination of student knowledge and participation. *Journal of Agricultural Education, 53*(4), 70-84. doi: 10.5032/jae.2012.04070

Lundry, J., Ramsey, J. W., Edwards, M. C., & Robinson, J. S. (2015). Benefits of career development events as perceived by school-based agricultural education teachers. *Journal of Agricultural Education, 56*(1), 43-57. doi: 10.5032/jae.2015.01043

Mabie, R., & Baker, M. (1996). A comparison of experiential instructional strategies upon the science process skills of urban elementary students. *Journal of Agricultural Education, 37*(2), 1-7. doi: 10.5032/jae.1996.02001

National Agricultural Statistics Service. (2009). Trends in U.S. agriculture. Retrieved from http://www.nass.usda.gov/Publications/Trends_in_U.S._Agriculture/Farm_Population/

National Council for Agricultural Education. (2016). *National quality program standards for agriculture, food and natural resource education.* Retrieved from https://www.ffa.org/SiteCollectionDocuments/tc_national_quality_program_standards_revised.pdf

National Council for Agricultural Education. (2015). *Agricultural, food and natural resources (AFNR) career cluster content standards.* Retrieved from https://www.ffa.org/SiteCollectionDocuments/council_afnr_career_cluster_content_standards.pdf

National Council for Agricultural Education. (2015). *Philosophy and guiding principles for execution of the supervised agricultural experience component of the total school based agricultural education program.* Retrieved from https://www.ffa.org/SiteCollectionDocuments/sae_guiding_principles.pdf

National FFA Organization. (2015). *Official FFA Manual.* Retrieved from https://www.ffa.org/about/who-we-are/official-manual

National FFA Organization. (2016). *Proficiencies.* Retrieved from https://www.ffa.org/participate/awards/proficiencies

National FFA Organization. (2016). *Supervised Agricultural Experience fact sheet agriscience research SAE.* Retrieved from https://www.ffa.org/MyResourceDocuments/sae_handbook_V10.pdf

National FFA Organization. (2017). *Agriscience fair.* Retrieved from https://www.ffa.org/participate/awards/agriscience-fair

National FFA. Organization Archives. (1916-2008). Ruth Lilly Special Collections and Archives, Indiana University-Purdue University Indianapolis, Indianapolis, IN. Accessed November 21, 2015.

Nilson, L. B. (2010). *Teaching at its best: A researched-based resource for college instructors.* San Francisco, CA: Jossey-Bass.

National Research Council. (2000). *Inquiry and the national science education standards: A guide for teaching and learning.* S. Olson & S. Loucks-Horsley (Eds.). Washington, D.C.: National Academy Press

Osborne, E. W. (1994). Completing the cycle. *The Agricultural Education Magazine, 67*(3), 3, 11.

Partnership for 21st Century Skills. (2015). *P21 framework definitions.* Retrieved from http://www.p21.org/storage/documents/docs/P21_Framework_Definitions_New_Logo_2015.pdf

Phipps, L.J., Osborne, E.W., Dyer, J.E., & Ball, A. (2008). *Handbook on agricultural education in public schools.* Clifton Park, NY: Delmar, Cengage Learning.

Ramsey, J. W., & Edwards, M. C. (2012). Entry-level technical skills that teachers expected students to learn through supervised agricultural experiences (SAEs): A modified Delphi study. *Journal of Agricultural Education, 53*(3), 42-55. doi: 10.5032/jae.2012.03042

Rateau, R. J., Kaufman, E. K., & Cletzer, D. A. (2015). Innovative classroom strategies that prepare college graduates for workplace success. *Journal of Agricultural Education, 56*(3), 52-68. doi: 10.5032/jae.2015.03052

Retallick, M. S., & Martin, R. (2008). Fifteen-year enrollment trends related to the three components of comprehensive agricultural education programs. *Journal of Agricultural Education, 49*(1), 28-38. doi: 10.5032/jae.2008.01028

Roberts, T. G. (2006). A philosophical examination of experiential learning theory for agricultural educators. *Journal of Agricultural Education, 47*(1), 17-29. doi: 10.5032/jae.2006.01017

Roberts, T. G., & Ball, A. L. (2009). Secondary agricultural science as content and context for teaching. *Journal of Agricultural Education*, *50*(1), 81-91. doi: 10.5032/jae.2009.01081

Rosch, D., Simonsen, J. C., & Valez, J. J. (2015). Examining year-long leadership gains in FFA members by prior FFA involvement, class year, and gender. *Journal of Agricultural Education, 56*(3), 227-241. doi: 10.5032/jae.2015.03227

Shoulders, C. W., & Myers, B. E. (2013). Teachers' use of experiential learning stages in agricultural laboratories. *Journal of Agricultural Education, 54*(3), 100-115. doi: 10.5032/jae.2013.0310

Steele, R. (1997) Analysis of the continuing decline in use of supervised agricultural experience (SAE) in New York State. *Journal of Agricultural Education, 38*(2), 49-58. doi: 10.5032/jae.1997.02049

Stewart, B. R., & Birkenholz, R. J. (1991). Outcomes of changing supervised agricultural experience programs. *Journal of Agricultural Education, 32*(3), 35-41. doi: 10.5032/jae.1991.03035

Talbert, B. A., Vaughn, R., Croom, D. B., & Lee, J. S. (2007). *Foundations on agricultural education.* Danville, IL: Professional Educators Publications, Inc.

Thoron, A. C., & Myers, B. E. (2012). Effects of inquiry–based agriscience instruction on student scientific reasoning. *Journal of Agricultural Education, 53*(4), 156-170. doi: 10.5032/jae.2012.04156

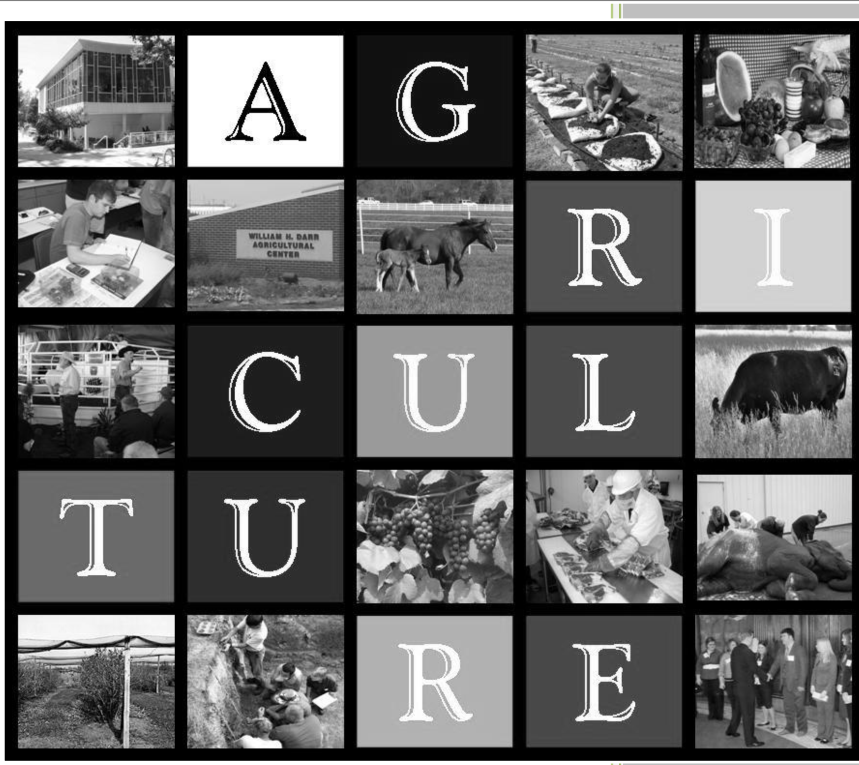
Townsend, C. D., & Carter, R. I. (1983). The relationship of participation in FFA activities and leadership, citizenship, and cooperation. *Journal of the American Association of Teacher Educators in Agriculture, 24*(1), 20-25. doi: 10.5032/jaatea.1983.01020

Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times.* San Francisco, CA: Jossey-Bass.

Wilson, E. B., & Moore, G. E. (2007). Exploring the paradox of supervised agricultural experience programs in agricultural education. *Journal of Agricultural Education, 48*(4), 82-92. doi: 10.5032/jae.2007.04082

APPENDIX A. 21ST CENTURY SKILLS PERCEIVED SELF-EFFICACY SURVEY

21st Century Skills



Brooke L. Thiel and
Adam A. Marx
North Dakota State
University
Agricultural
Education

Dear Student,

The goal of our high schools is to prepare our young people, such as you, for the future. The challenge in today's ever-changing world, is to prepare you for a future that we cannot predict. In addition to the traditional coursework, many educators believe there is value in teaching students 21st Century Skills, or skills that will benefit students in many different careers in the future.

The purpose of this study is to look at the relationship between your experiences in high school and your attainment of 21st Century Skills. The information you provide will help teachers across the country prepare students for the future.

Your participation in this study is voluntary and you may choose to withdraw at any time without penalty or consequence. There are no known risks resulting from your participation and no direct benefit from your participation is expected. There is no cost to you except your time. The instrument will take about 15 minutes to complete.

The information that you provide through the completion of the instrument will be kept secure and separate from your name in the processing and reporting of data. Your answers will reflect only your opinion and will have no bearing on anything related to your grades in school.

Thank you for your time and your willingness to help us better understand your experience as a high school student.

Sincerely,

Brooke L. Thiel
Graduate Student
Brooke.Thiel@k12.nd.us

Adam A. Marx
Assistant Professor
adam.marx@ndsu.edu

Section 1

Section 1 is designed to collect some information about you. It will not be tied to you but will let us know a few things about you as an individual. It will allow you to give a few more specifics about yourself and your specific high school experiences.

1) Please circle your current year in high school: Sophomore Junior Senior

2) Gender: ______ Male ______ Female

3) Have you ever been enrolled in an Agricultural Education course? **(If no, go to Section 2 on page 4)**

_______Yes _______ No

If you were ever enrolled in an agricultural education course, please answer the following questions:

4) Did you have a Supervised Agricultural Experience (SAE)? _______ Yes _______ No (**If no, go to #6**)

5) Please circle your SAE area(s) (all that apply):

Entrepreneurship Placement Research Exploratory Other

6) Have you ever completed an Agriscience research project? (**If no, go to #12**)

_______ Yes _______ No

7) How many Agriscience research projects have you completed? (circle below)

0 1 2 3 4 5+

8) How long have you been conducting Agriscience Research (can include multiple projects)? (circle below)

a. Less than 1 year b. 1 year c. 2 years d. 3 years e. More than 4 years

9) Have you competed in the Agriscience Fair? _______ Yes _______ No

If yes, circle all of the level(s) at which you have competed in the Agriscience Fair.

a. Local b. District/Area/Regional c. State d. National

10) Have you completed any Agriscience Research Proficiency Awards?

_______ Yes _______ No

If yes, please circle the highest level your proficiency award advanced:

a. Local b. District/Area/Regional c. State d. National

11) Have you ever received any Star in Agriscience Awards? _______ Yes _______ No

If yes, please circle the level(s) at which you received Star in Agriscience Awards:

a. Local b. District/Area/Regional c. State d. National

b.

12) Have you ever been an FFA member? _______ Yes ________ No

13) Have you ever served as a chapter officer? _______ Yes _______ No

14) Have you ever competed in Career Development Events (CDEs)?

_______ Yes _______ No

If yes, how many ***different*** CDEs have you participated in? (circle below)

1 2 3 4 5 6 7 8 9 10+

Section 2

INSTRUCTIONS

For each statement below, please read carefully and rate how confident you are that you can accomplish each task today. Rate ***your*** degree of confidence by recording a number from 0 to 100 in the column labeled confidence, using the scale given below:

Example:

0	10	20	30	40	**50**	60	70	80	90	**100**
Cannot do at all					**Moderately can do**					**Highly certain can do**

Rate how confident you are that you can currently accomplish each task using the provided 0 to 100 scale:

RATE YOUR DEGREE OF CONFIDENCE:	**Confidence 0-100**
1. I am able to work well in a group.	100
2. I am responsible.	50
3. I can remain focused on tasks.	0

Example Interpretations:

a. If you selected "100" for "I am able to work well in a group" as it shows in the example, that would mean that there is no doubt in your mind you could accomplish that.

b. For the second question, "50" was chosen. In this example, you would be moderately certain you could do that task.

c. For the third question, "0" was selected, which means that you feel you are completely unable to "remain focused on a task."

Please proceed with answering the questions of Section 2 in the same manner.

SECTION 2 INSTRUCTIONS: ****PLEASE WRITE LEGIBLY****

For each statement below, please read carefully and rate how confident you are that you can accomplish each task today. Rate ***your*** degree of confidence by recording a number from 0 to 100 in the column labeled confidence, using the scale given below:

0	10	20	30	40	**50**	60	70	80	90	**100**
Cannot do at all					**Moderately can do**					**Highly certain can do**

RATE YOUR DEGREE OF CONFIDENCE:		**Confidence 0-100**
1.	I can construct and defend an argument.	_______
2.	I am able to generate new ideas.	_______
3.	I am able to determine the reliability of information published in a wide range of sources.	_______
4.	I understand how and why media (public communication) messages are made.	_______
5.	I am able to use technology as a tool to research, organize, and communicate information.	_______
6.	I am able to revise my own ideas when presented with new information or evidence.	_______
7.	I am able to set goals	_______
8.	I know when it is appropriate to listen.	_______
9.	I can set and meet goals, even in the face of obstacles and other pressing responsibilities.	_______
10.	I am able to influence and guide others towards a goal.	_______
11.	I am able to design and conduct research.	_______

SECTION 2, cont. ****PLEASE WRITE LEGIBLY****

Please complete the following statements by rating your degree of confidence by recording a number between 0 and 100 in the column labeled **confidence:**

0	10	20	30	40	**50**	60	70	80	90	**100**
Cannot do at all					**Moderately can do**					**Highly certain can do**

	RATE YOUR DEGREE OF CONFIDENCE:	**Confidence 0-100**
12.	I can respond to critical questions about my opinions, explanations, and findings.	_______
13.	I am able to evaluate new ideas.	_______
14.	I am able to gather data and evidence from a wide range of sources including journal articles, computer databases, and books.	_______
15.	I understand how people interpret media (communication) messages differently.	_______
16.	I can use digital technologies (ex. Computers) to access, manage, and create information to successfully function in today's world.	_______
17.	I am able to distinguish the difference between theories and opinions.	_______
18.	I can prioritize, plan, and manage work to achieve the best results.	_______
19.	I am able to get the best out of other people on my team to accomplish a common goal.	_______
20.	I am able to use various types of reasoning to solve problems.	_______
21.	I am able to communicate my ideas, opinions, and findings clearly for many audiences.	_______
22.	I am innovative and can create new and worthwhile ideas.	_______
23.	I am able to find information efficiently and effectively.	_______

SECTION 2, cont. ****PLEASE WRITE LEGIBLY****

Please complete the following statements by rating your degree of confidence by recording a number between 0 and 100 in the column labeled **confidence:**

0	10	20	30	40	**50**	60	70	80	90	**100**
Cannot do at all					**Moderately can do**					**Highly certain can do**

RATE YOUR DEGREE OF CONFIDENCE:		**Confidence 0-100**
24.	I understand how opinions and points of view are included or excluded in the media (public communication).	_______
25.	I am able to use social networks to access, manage, and create information to function in today's world.	_______
26.	I am comfortable applying my knowledge and reasoning skills to a variety of new situations and new areas of study.	_______
27.	I am able to utilize my time and manage my workload efficiently.	_______
28.	I conduct myself in a respectable and professional manner.	_______
29.	I am able to work positively.	_______
30.	I can inspire others to reach their best by leading by example.	_______
31.	I am able to use a wide range of communication tools including graphs, charts, and tables to communicate statistics, data, and research.	_______
32.	I am able to use a wide range of idea creation techniques, such as brainstorming.	_______
33.	I can evaluate information carefully and successfully.	_______
34.	I understand how the media (public communication) can influence beliefs and behaviors.	_______
35.	I am open to change.	_______

SECTION 2, cont. ****PLEASE WRITE LEGIBLY****

Please complete the following statements by rating your degree of confidence by recording a number between 0 and 100 in the column labeled **confidence:**

0	10	20	30	40	**50**	60	70	80	90	**100**
Cannot do at all					**Moderately can do**					**Highly certain can do**

	RATE YOUR DEGREE OF CONFIDENCE:	**Confidence 0-100**
36.	I am able to work independently and complete tasks without being told to do so.	______
37.	I am an ethical person.	______
38.	I use ethical behavior and integrity when in a leadership role.	______
39.	I can analyze and evaluate evidence, arguments, claims, and beliefs.	______
40.	I am able to expand an idea in order to improve and maximize it to its fullest potential.	______
41.	I have an understanding of the ethical and legal issues surrounding the access and use of media (means of public communication).	______
42.	I am able to articulate my ideas and thoughts effectively using written skills in a variety of ways and situations.	______
43.	When solving problems, I am able to understand many different ideas and opinions and use them to reach a solution.	______
44.	I can work effectively with people from a range of social and cultural backgrounds.	______
45.	I can manage time and projects effectively.	______
46.	I act responsibly with the interests of the larger community in mind.	______
47.	I am able to analyze and evaluate differing points of view.	______

SECTION 2, cont. ****PLEASE WRITE LEGIBLY****

Please complete the following statements by rating your degree of confidence by recording a number between 0 and 100 in the column labeled **confidence:**

0	10	20	30	40	**50**	60	70	80	90	**100**
Cannot do at all					**Moderately can do**					**Highly certain can do**

RATE YOUR DEGREE OF CONFIDENCE:		**Confidence 0-100**
48.	I am able to articulate my ideas and thoughts effectively using oral communication skills in a variety of ways and situations.	_______
49.	I am able to analyze and improve ideas.	_______
50.	I am confidently able to use information without plagiarizing.	_______
51.	I am able to articulate my ideas and thoughts effectively using nonverbal communication skills in a variety of ways and situations.	_______
52.	I understand and am able to create media (communication messages) using the appropriate tools.	_______
53.	I am not discouraged by setbacks and criticism.	_______
54.	When learning, I go beyond the minimum which is required in order to explore and expand my own learning.	_______
55.	I am open-minded to different ideas and values.	_______
56.	I am able to multi-task.	_______
57.	I am able to make connections between facts and opinions.	_______
58.	I am able to use information accurately and creatively for the problem or issue at hand.	_______
59.	I participate actively in groups.	_______

SECTION 2, cont. ****PLEASE WRITE LEGIBLY****

Please complete the following statements by rating your degree of confidence by recording a number between 0 and 100 in the column labeled **confidence:**

0	10	20	30	40	**50**	60	70	80	90	**100**
Cannot do at all					**Moderately can do**					**Highly certain can do**

RATE YOUR DEGREE OF CONFIDENCE:		**Confidence 0-100**
60.	I understand and am able to effectively make statements in diverse, multi-cultural environments.	________
61.	I can work effectively, even when answers are unknown and being sought.	________
62.	I seek opportunities to advance my skills towards a professional level.	________
63.	I am effective at communicating for a range of purposes (e.g. to inform, instruct, motivate, persuade).	________
64.	I am able to use social and cultural differences in order to create new ideas.	________
65.	I am reliable.	________
66.	I can understand information and draw conclusions.	________
67.	When communicating, I am able to utilize multiple types of media and technologies.	________
68.	I am able to make connections between information from many different sources.	________
69.	I am able to take and use feedback effectively.	________
70.	I seek opportunities which will lead me to become an expert at something.	________
71.	I can assess the effectiveness and impact of various media and technologies.	________

SECTION 2, cont. ****PLEASE WRITE LEGIBLY****

Please complete the following statements by rating your degree of confidence by recording a number between 0 and 100 in the column labeled **confidence:**

0	10	20	30	40	**50**	60	70	80	90	**100**
Cannot do at all					**Moderately can do**					**Highly certain can do**

	RATE YOUR DEGREE OF CONFIDENCE:	**Confidence 0-100**
72.	In a team, I am able to use social and cultural differences to create high-quality, innovative results.	________
73.	I present myself professionally.	________
74.	I am able to reflect on learning experiences.	________
75.	I can communicate effectively in many different environments.	________
76.	I am able to incorporate group input and feedback into my work.	________
77.	I am able to multi-task many different roles, responsibilities, and schedules.	________
78.	I am committed to learning for the rest of my life.	________
79.	I use proper etiquette appropriate to the situation (socially acceptable behavior).	________
80.	I am able to solve new problems in traditional and innovative ways.	________
81.	I am able to work effectively and respectfully with diverse teams.	________
82.	I am able to develop, implement, and communicate new ideas to others effectively.	________
83.	I use my past learning experiences to guide my future growth.	________

SECTION 2, cont. ****PLEASE WRITE LEGIBLY****

Please complete the following statements by rating your degree of confidence by recording a number between 0 and 100 in the column labeled **confidence:**

0	10	20	30	40	**50**	60	70	80	90	**100**
Cannot do at all					**Moderately can do**					**Highly certain can do**

RATE YOUR DEGREE OF CONFIDENCE:		**Confidence 0-100**
84.	I am original and inventive.	______
85.	I am accountable and follow-through.	______
86.	I can act on my creative ideas by implementing them.	______
87.	I can produce results (make things happen).	______

Thank you for your time!

North Dakota State University
School of Education
College of Human Development and Education

PO Box 6050
Fargo, ND 58108-6050

PHONE (701) 231-7439
FAX (701) 231-9685
www.ndsu.edu/education

APPENDIX B. IRB PRINCIPAL APPROVAL LETTER

[DATE], 2016

[NAME] – [SCHOOL NAME] High School Principal

The North Dakota State University Agricultural Education Program and I invite you to take part in a quantitative study describing the perceived self-efficacy of high school students' attainment of 21st Century Skills. North Dakota State University Agricultural Education Department holds your Agricultural Education Instructor [TEACHER NAME] and the [SCHOOL NAME] Agricultural Education program in high regard, and for that reason students of this program have been identified as potential candidates for my Master's research project. The self-perceived attainment of 21st Century Skills by sophomores, juniors, and seniors enrolled in agricultural education will be compared to those students that have not been enrolled in agricultural education at each participating school in the study. Further, results will be compared to measure what experiences within agricultural education may lead to the attainment of 21st Century Skills.

My name is Brooke Thiel and I am currently a graduate student in Agricultural Education, along with currently being a high school agricultural education instructor in Kindred, North Dakota. I, along with my Advisor Dr. Adam Marx – NDSU Agricultural Education Assistant Professor, will be conducting this research project for my master's thesis. Each sophomore, junior, and senior student enrolled in the [SCHOOL NAME] High School will be asked to complete a 100 item questionnaire that will take approximately 30 minutes to complete.

No identifying information will be collected on questionnaires. Reporting of the findings will be anonymous and will not reflect upon your school in any way. Disruption of class time will be minimized as much as possible, and would be held at a time convenient for the school district, teacher, and students. The only reason I request meeting in your high school is because this is the most convenient for the students and assures accuracy of questionnaire administration.

Active parental consent is not being sought for this study as it is focusing on student's perceptions of their current level of 21st Century Skills. With the help of the agricultural education teacher(s), we intend to inform parents of the research via an emailed letter. Parents may choose to opt their children out of the study and students may opt out at any time during the survey. There is no treatment and the topic is not believed to be controversial or of emotional/psychological detriment to the participants. Permission will be obtained from [TEACHER], and assent from the students themselves. These assent/consent letters will provide detailed information on the project. You can gain further information regarding this research project by contacting me, Brooke Thiel at (701) 866-4219 or email at Brooke.Thiel@k12.nd.us or you may call my advisor, Dr. Adam Marx, at 701-231-7479 or adam.marx@ndsu.edu. For more information about the student's rights as human subjects please contact the NDSU campus Institutional Review board at (701) 231-8995 or (855) 800-6717.

I hereby give my permission for Brooke L. Thiel to conduct the research questionnaire to sophomore, junior, and senior students of the [SCHOOL NAME] School District.

Principal Signature Date

Sincerely,

Brooke L. Thiel &
Dr. Adam A. Marx, Assistant Professor

APPENDIX C. IRB PARENT CONSENT LETTER

North Dakota State University Study of the Influence of Agriscience Research on the Perceived Self-Efficacy of High School Students' Attainment of 21st Century Skills

[DATE], 2016

Dear Parent,

My name is Brooke Thiel. I'm a graduate student in the Agricultural Education Department at North Dakota State University in Fargo, North Dakota. I'm conducting a research study as part of the requirements of a Master of Agricultural Education degree, and I would like to extend an invitation for your child to be a part of the study.

I received permission from [SCHOOL NAME] High School Principal [PRINCIPAL NAME] and Agricultural Education Teacher [TEACHER NAME] to conduct a research questionnaire survey study that was designed by my North Dakota State University Advisor Dr. Adam Marx and me. The study will survey all sophomore, junior, and senior high school students about their experiences in agricultural education and their perceptions of their current level of attainment of 21st Century Skills. I am inviting all sophomore, junior, and senior students enrolled in [SCHOOL NAME] High School to take part in this survey research.

Purpose.

The goals of this research includes; to understand how students perceive their current level of identified 21st Century Skills (also referred to as soft skills) and determine what experiences (especially those related to agricultural education) influence the attainment of 21st Century Skills. Examples of 21st Century skills includes: communication skills, critical thinking/problem solving, and leadership skills among others. If we can identify and describe the experiences that lead to the attainment of 21st Century Skills, we can better prepare students for careers in the 21st century.

Procedures.

This research involves distributing a paper questionnaire during a regularly scheduled class period to your sophomores, juniors, and seniors. Total administration time for the two-part questionnaire should be approximately 30 minutes. Students' participation in this survey is totally voluntary. Your child does not have to take part in the study or can simply just answer the questions you feel comfortable in answering. The survey will not be individually scored; student's data will be combined with all other participant's data to come up with an average. All information will be keep confidential and once all the surveys are evaluated, they will be destroyed.

The results of the study may be published or presented at professional conferences or journals, Participation is once again anonymous and your child's personal answers to the survey questions will not identified. Participation in this study will have no effect on current grades in the agriculture or other classes that your child is presently enrolled in. The student may quit taking the survey at any time.

Benefits.

Participation in this research may benefit your student by challenging them to think about their current level of 21st Century Skill attainment. This research will add to the existing literature on effective secondary education instructional practices.

Consents and Safeguards.

Confidentiality will be maintained throughout this study. All student information will be confidential. The highest priority will be placed on making sure the study is a positive experience for all that take part. To accomplish this, I (the researcher) will abide by the following guidelines:

1) All information will be kept confidential and anonymous.
2) Participation in this study should not involve risk beyond what is faces in a typical school day.
3) The researcher will be friendly and aim to make this study enjoyable for your child.
4) Individual answers to survey questions will remain anonymous, and no identifying factors will be used in the study.
5) Once data is collected it will be stored in a locked cabinet. Electronic data results will be password protected, once the research study is finalized data collected results will be destroyed.

More Information and Opt-Out Procedures

I will be happy to answer any questions that you may have on this research study. You may contact me at 701-866-4219 or email me at Brooke.Thiel@k12.nd.us or you may call my advisor, Dr. Adam Marx, at 701-231-7479 or adam.marx@ndsu.edu. *If you would prefer that your child not participate in this study, please call or email me (Brooke) directly. Or if you prefer, please contact your high school principal and inform them you would prefer your child not participate in the Self-Perceived Efficacy study.*

For more information about the student's rights as human subjects please contact the NDSU campus Institutional Review board at (701) 231-8995 or (855) 800-6717.

Thank you for your consideration. I am very excited that the possible outcomes of this study will help to further understand the benefits of agricultural education.

Sincerely,

Brooke Thiel &

Dr. Adam Marx – Academic Advisor

APPENDIX D. IRB TEACHER APPROVAL LETTER

North Dakota State University Study of the Influence of Agriscience Research on the Perceived Self-Efficacy of High School Students' Attainment of 21st Century Skills

[DATE], 2016

[TEACHER NAME]

[SCHOOL NAME] High School

Agricultural Education Teacher

Dear [TEACHER NAME]:

Thank you for taking time to consider this important research project. I (the researcher) am inviting the sophomore, junior, and senior high school students to participate in this research study. This letter provides information on the study and what will be asked of your students.

Purpose.

The goals of this research include; to understand how students perceive their current level of identified 21st Century Skills and determine what experiences (especially those related to agricultural education) influence the attainment of 21st century skills. If we can identify and describe the experiences that lead to the attainment of 21st Century Skills, we can better prepare students for careers in the 21st century.

Procedures.

This research involves distributing a paper questionnaire during a regularly scheduled class period to your sophomores, juniors, and seniors. Total administration time for the two-part questionnaire should be approximately 30 minutes. Your participation, and the participation of your students, is completely voluntary. Responses to all questionnaires will be kept strictly anonymous.

Benefits.

Following completion of this research, you will be given a copy of all findings. You may benefit from participating in this research by thinking about new ways to increase the level of attainment of 21st Century Skills.

Consents and Safeguards.

I (the researcher) place the highest priority on making sure that participation in the study is a positive experience for all and is minimally intrusive to the program. To accomplish this, I, the researcher, will abide by the following guidelines:

1. You can terminate your involvement in the study at any point you wish.
2. All information gathered will be kept strictly anonymous.
3. The researchers will strive to be friendly and aim to make the study as smooth and enjoyable for you and your students as possible.
4. Risks are minimal. Potential risks are not expected to be greater than those that exist in a typical classroom setting.
5. Questionnaires will remain completely annonymous. Any identifying factors will be removed from any portions utilzied or quoted in the final product.
6. Once data from the paper questionnaires are entered into the computer, they will be stored in a locked cabinet. Electronic data will be password protected on my office computer.

Your Participation.

- If you are willing to allow your students to participate in this study, please return the attached form by [DATE] to Brooke Thiel or email me at Brooke.Thiel@k12.nd.us or you may call my advisor, Dr. Adam Marx, at 701-231-7479 or adam.marx@ndsu.edu.

- If you have further questions you would like addressed, please do not hesitate to contact the researcher by phone at (701) 866-4219.

- I will be happy to provide a copy of the survey questionnaire if needed. Should you have questions about your rights concerning the study, you may also contact the North Dakota State University Review Board at (701) 231-8995 or (855) 800-6717.

I am very excited about the possibilities of this study and what it will tell us about our high school students' attainment of 21st Century Skills. I hope you are interested!

Sincerely,

Brooke L. Thiel	Dr. Adam A. Marx
Graduate Student	Assistant Professor
Agricultural Education	Agricultural Education

Agriculture Teacher/FFA Advisor Consent Form

You understand that:

1. This study is part of a research effort to learn about youths' attainment of 21^{st} Century Skills.
2. This study is examining what agricultural education experiences lead to the attainment of 21^{st} Century Skills of sophomore, junior, and senior high school students.
3. My participation is voluntary.
4. You may terminate participation at any point.
5. The risks associated with this study are minimal.
6. You will be asked to identify sophomore, junior, and senior students
7. Questionnaires will be kept anonymous.
8. Your participation in this project should not involve risks beyond those faced in a typical classroom setting.
9. You will not be identified in any way.
10. You may have a copy of this assent form.
11. You may benefit by thinking about agricultural education experiences that lead to the attainment of 21^{st} Century Skills.
12. Once data from the paper questionnaires are entered into the computer, they will be stored in a locked cabinet by the researcher. Electronic data will be password protected on the researcher's office computer.

I further understand that all information provided will be kept confidential and that I may have a copy of the consent form. Any questions about this study may be directed to me, Brooke L. Thiel, at (701) 866-4219 or by email at Brooke.Thiel@k12.nd.us or you may call my advisor Dr. Adam Marx at 701-231-7479 or adam.marx@ndsu.edu. Questions concerning your rights as a participant can be directed to the North Dakota State University Institutional Review Board (IRB) at (701) 231- 8995 or (855) 800-6717.

PLEASE RETURN ALL PAGES OF THIS DOCUMENT REGARDING YOUR PERMISSION TO PARTICIPATE IN THIS STUDY. AN ADDITIONAL COPY OF THESE DOCUMENTS WILL BE PROVIDED FOR YOUR OWN PERSONAL RECORDS.

I choose to:

Participate __________ Not participate __________

Signature ________________________________

Please print your full name:

____

First Name Middle Initial Last Name

Return by (DATE) to: Brooke L. Thiel; 255 Dakota Street, Kindred, ND 58051

APPENDIX E. IRB YOUTH ASSENT FORM

Youth Informed Assent Form

North Dakota State University Study of the Influence of Agriscience Research on the Perceived Self-Efficacy of High School Students' Attainment of 21st Century Skills

You understand that:

1. This study is part of a research effort to learn about youths' attainment of 21st Century Skills. (Examples of 21st Century skills includes: communication skills, critical thinking/problem solving, and leadership skills among others)
2. This study is examining your perceived self-efficacy regarding 21st Century Skills.
3. Your participation is voluntary.
4. This survey will take approximately 30 minutes to complete.
5. You may stop participation at any point.
6. You will be asked to complete a paper questionnaire on 21st Century Skills.
7. Your responses to the questionnaire will be completely anonymous.
8. The risks associated with this study are no more than you face in a typical day participating in a typical classroom setting.
9. You will not be identified in any way.
10. You may have a copy of this assent form.
11. You may benefit by thinking about your current level of attainment of 21st Century Skills.
12. Once data from the paper questionnaires are entered into the computer, they will be stored in a locked cabinet. Electronic data will be password protected on an NDSU office computer.

You further understand that all information provided will be kept anonymous. Any questions about this study may be directed to Brooke Thiel at 701-866-4219 or by email at Brooke.Thiel@k12.nd.us or you may call my advisor Dr. Adam Marx at 701-231-7479 or adam.marx@ndsu.edu. Questions concerning your rights as a participant can be directed to the NDSU Institutional Review Board (IRB) at (701) 231-8995.

Thank you for your consideration and participation!!

APPENDIX F. IRB STUDENT ANNOUNCEMENT/RECRUITMENT FORM

Student Announcement/Recruitment Form

Influence of Agriscience Research on the Self-Perceived Efficacy of High School Students' Attainment of 21st Century Skills

Classroom Announcement:

Teacher Reads:

You have the opportunity to help a researcher, Mrs. Brooke Thiel, from North Dakota State University in the Agricultural Education Program learn more about how you have attained 21st Century Skills! Brooke is working on a research project titled, **Influence of Agriscience Research on the Self-Perceived Efficacy of High School Students' Attainment of 21st Century Skills.** Your participation in this study is entirely voluntary and will not influence any of your grades in any way.

If you are interested in learning more about this study to determine if you would like to participate, please see me for a letter. Your parents will be notified through a school email and the informative letter I have given to each of you. Your participation would greatly assist Brooke in completing her research project.

Before you decide whether to participate in this study or not, please take the time to read the letter and ask any questions that might come up.

Brooke greatly appreciates your consideration!