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By John Schut

Entitled Relationships Between Agriscience Education Student Achievement in Science and Agriscience Teacher Certification

For the degree of Doctor of Philosophy

Is approved by the final examining committee:

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Jerry L. Peters ______________________________________

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RELATIONSHIPS BETWEEN AGRISCIENCE EDUCATION STUDENT ACHIEVEMENT IN SCIENCE AND AGRISCIENCE TEACHER CERTIFICATION

A Dissertation

Submitted to the Faculty

of

Purdue University

by

John Harley Schut

In Partial Fulfillment of the

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of

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For my wife and daughter.

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ABSTRACT

Schut, John Harley, Ph.D., Purdue University, December 2008. Relationships Between Agriscience Education Student Achievement in Science and Agriscience Teacher Certification. Major Professor: Mark A. Balschweid.

The purpose of the study was to investigate the relationships between agriscience education student achievement on a state science assessment test and agriscience teacher certification categorized as either professional or provisional. Science integration in agriscience programs is a trend in response to federal mandates for increased student academic achievement and elevated teacher certification standards in relation to Public Law 107-110, also known as the No Child Left Behind Act. In the study, science scores of agriscience students with agriscience teachers of different certification types were compared as well as the mean science scores of the sample to the general population. The sample consisted of completers of Michigan high school agriscience programs with science scores taken from the Michigan Educational Assessment Program. The agriscience population science test mean was not found to be statistically different from that of the general student population. The independent variables of teacher certification, gender and socioeconomic status did not have a statistically significant relationship with the dependent variable of science achievement.

CHAPTER 1 INTRODUCTION

Background

Education is important to our country because it influences the earning potential of individuals within the labor force (United States Bureau of Labor Statistics, 2006). In recent years, the emphasis on competency testing throughout the United States has focused on the knowledge students possess at different points in their educational experience (Education Commission of the States, 2008a). The ever-increasing focus on grade level testing has also garnered attention from individuals involved with teacher preparation and certification (Education Commission of the States, 2008b).

Agriscience education programs have a tradition of serving students through classroom education, leadership development and experience-based learning opportunities (Hoover, Scholl, Dunigan & Maontova, 2007). These programs often implement leadership development through the National FFA Organization and develop experience-based learning opportunities through Supervised Agricultural Experience (SAE) Programs. Classroom education is developed through theoretical and laboratory instruction in the production, science, business and technology of agriscience (Hoover et al., 2007).

In 1988, many Michigan public high schools (N=119) started offering agriscience classes for science credit. Since then, greater demands have been placed on science-based objectives in addition to the existing career and technical education standards within each agriscience course (C. Arensmeier, personal communication, May 20, 2004). The need for science certification in addition to agriscience certification of teachers became necessary as a number of agriscience programs shifted their instruction from a vocationally-oriented approach to a more science-oriented approach. The additional certification was also necessary to ensure that teachers were competent in the expanded technical knowledge in the sciences (C. Arensmeier, personal communication, May 20, 2004).

The Michigan Department of Education assesses student knowledge of the Michigan Curriculum Framework using the Michigan Education Assessment Program (MEAP). The high school MEAP test is traditionally given during the 11^{th} grade of high school, but 10^{th} grade students may request to be tested as well (Michigan Department of Education, 2008a). The MEAP test assesses the areas of language arts, mathematics, science and social studies. Raw scores of science determine placement into four scale score levels (Michigan Department of Education, 2008a). Testing cycles during Spring 2003 and 2004 were investigated in this study. During that cycle, MEAP Science scores were classified into four levels (2008a):

- Level 1 is labeled *Endorsed and Exceeded Michigan Standards* with raw scores of 637 and above out of a total of 1136 points.
- Level 2 is labeled *Endorsed and Met Michigan Standards* with a score range of 530 – 636.
- Level 3 is labeled *Endorsed at Basic Level* with raw scores of 500 – 529.
- Level 4 is labeled *Not Endorsed* with scores of less than or equal to 499.

In addition to school assessment of student achievement, individual students who score at Level 1 or Level 2 in all subject areas earn a $2500 scholarship (State of Michigan, 2008).

According to the Michigan Department of Education (2008b), there are two major levels of teacher certification in the state. The first level of teacher certification is a provisional certification. This level of certification is generally for those who are recent baccalaureate graduates from one of thirty-two universities in Michigan that prepare teachers such as Michigan State University, the University of Michigan, Central Michigan University and Western Michigan University. In order to obtain the second level of certification, the professional certificate, the teacher must either complete a Master of Arts or Master of Science degree in approved areas or complete 18 semester credit hours in an approved course of study within the first six years of the license. In addition, three years of teaching is required for the professional certificate. Once granted, the professional certificate is valid for five years. Within the five years of the professional certificate, the teacher must seek continuous professional growth and in-service training as measured by Continuing Education Units (CEUs). This is earned by attending state-approved in-service training and workshops (Michigan Department of Education, 2008b).

The Michigan Department of Education (2008b) also grants annual authorization. An annual authorization certification is valid within a subject area for one year and authorizes a candidate with at least 4000 documented hours of work experience to teach only in a career and technical education program such as an agriscience program. The state supervisor of agricultural education annually reviews this authorization certificate (R.J. Showerman, personal communication, March 5, 2008).

Michigan State University (2008a) houses the only teacher certification program for individuals to become certified to teach secondary agriscience education in Michigan. The Department of Community, Agriculture, Recreation and Resource Studies within the College of Agriculture and Natural Resources administers this program (2008a). Students traditionally complete a Bachelor of Science degree in Environmental Studies and Agriscience with a concentration in Teacher Certification in Agriscience and Natural Resources (ANR) Education and then complete a yearlong teaching internship following undergraduate graduation for completion of a five-year teacher preparation program. Students also complete a teaching minor in academic areas such as biology, earth science, physics or chemistry. Other teaching minors include mathematics, language arts, and social studies. A majority of the agriscience teachers included in this study completed a science-related minor. Upon completion of the five-year agriscience teacher preparation program, students emerge from Michigan State University with a provisional teaching certificate in agriscience education and a teachable minor in addition to vocational certification (Michigan State University, 2008b).

Statement of the Problem

Currently, the increased demand on high school performance has been affected by a “report card” that is released by the Michigan Department of Education (2008c). This Michigan Department of Education report card assigns each school a letter grade based on an index of performances. One-third of the grade is based on school and community activities and outreach. The other two-thirds of the grade is based on student performance on the MEAP test (Michigan Department of Education, 2008c).

According to the United States Department of Education (2008a), state assessment of a local school's performance in student achievement is driven by the federal government's increased expectations on student learning and teacher certification. The Elementary and Secondary Education Act of 1965 (Public Law 89-10) was re-authorized in 2002 with Public Law 107-110, also known as the "No Child Left Behind" Act (NCLB). The law places strict mandates on student performance and teacher qualifications (United States Department of Education, 2008b). A component of the legislation is to close achievement gaps of under-achieving students measured by student assessments at the state level. In Michigan, student assessment is measured with the Michigan Education Assessment Program (Michigan Department of Education, 2008a).

Another component of No Child Left Behind is in the area of teacher certification (United States Department of Education, 2008b). Federal policy outlines that schools comply with the federal law and that they carefully analyze their staff's qualifications and certifications. Specifically, teachers must be certified as "highly qualified" within a specific field in order to teach within that field according to the federal guidelines. They meet the "highly qualified" criteria if they pass a basic proficiency test and subject area tests of that certifying area (2008d).Current Michigan teachers meet certification requirements of No Child Left Behind if they are granted a degree from a certifying unit and are teaching within their certification area (Michigan Department of Education, 2008d).

A majority of Michigan agriscience programs offer science credit for their classes (R.J. Showerman, personal communication, June 25, 2007). As agriscience students acquire science credit for these courses, federal and state mandates call for accountability for the qualifications of teachers and the performance of students (United States Department of Education, 2008b). Based of the factors of science credit for agriscience courses, teacher qualifications and student achievement, this study analyzed the variable of teacher certification and its impact on student achievement.

Purpose of the Study

The purpose of the study was to investigate the relationships between agriscience education student achievement in science and agriscience teacher certification. In order to better understand existing teacher certification impacts, evidence must show the effect of certification on student achievement in science. Factors such as gender may impact student achievement; in addition, the study will also consider the socioeconomic status of the student's school district as a confounding variable.

Guiding Research Objectives

To specifically address the purpose of the study, the following objectives were outlined:

1. Identify the Michigan population of agriscience teachers and classify their teaching certificate type and certification areas;
2. Identify completers of high school agriscience programs and determine their categorical score and raw score on the MEAP science test and compare the agriscience program completer population to the general population;
3. Investigate the socioeconomic status of the schools included in the study and use in analysis as a confounding variable;

4. Investigate the relationship between teacher certification and student achievement in science on the MEAP science test measured by raw scores and also analyze the variables of gender and socioeconomic status; and
5. Investigate the variables of teacher certification, gender and socioeconomic status on the MEAP science test measured by placement level.

To address these objectives, this study will analyze MEAP science data from the 2003-04 and 2004-05 academic years collected on program completers of high school agriscience programs in Michigan. According to the Office of Career and Technical Educational of the Michigan Department of Education (2008e), a program completer is a 11th or 12th grade student who has successfully completed with a “C” average the course of study as prescribed by a local program. An example would be a student who has completed two years of coursework in one or more of the following curricular areas: botany, soil sciences, zoology, natural resources, business management, marketing, and technical systems (Michigan Agriscience and Natural Resources Education, 2008).

The null hypothesis for the research objectives was that no relationship exists between variables. The alternate hypothesis was that a relationship exists between the variables. Primary data included student science scores from the MEAP science test and socioeconomic status of the school defined as the percentage of economically disadvantaged students within the school by Standard and Poor’s.

Rationale for the Study

This study was supportive of research in the field of agriscience education because it addressed a national movement increasing sciences in agriscience programs. Because a majority of agriscience teachers in Michigan hold teaching science minors other than agriscience and many agriscience programs offer science credit for agriscience courses (R.J. Showerman, personal communication, June 25, 2007), the researcher supported the position that agriscience education meets science learning based on the qualifications that current high school agriscience teachers possess. The study also considered variables that relate to student achievement such as gender and socioeconomic status to better understand their effects on agriscience student achievement in science. Based on the synthesis in the Review of Literature discussed in Chapter 2, the study investigated the effect of agriscience education's role in science education within Michigan high schools that offer agriscience programs.

Assumptions

The investigator made the following assumptions based on a review of the literature:

1. Teachers involved in this study are certified at the provisional or professional level as licensed by the state of Michigan.
2. A majority of agriscience teachers in Michigan have a major in agriscience education and a minor in a science.
3. Subjects identified in the study are completers of traditional high school agriscience programs and not of career technical centers.
4. Agriscience program completers are students who have completed the local program course of agriscience classes and have been instructed in scientific principles through the course of their studies counted as science credit.

5. Program completers have also completed a minimum of two years of core science classes such as biology and physical science.
6. Completers were either juniors or seniors in high school and regularly enrolled students in Michigan high schools.
7. Science scores from the Michigan Education Assessment Program are based on scientific questions derived from the Michigan Science Benchmarks.
8. Science tests are administered using standardized procedures and scoring.
9. Michigan Department of Education science standards and tests were consistent during the data collection period.
10. The science scores were obtained during the individual student's 11^{th} grade year and during the 10^{th} grade year of some students.
11. Socioeconomic status is a confounding variable related to achievement and was considered through statistical analysis.

Limitations

The study was limited to analyzing agriscience student achievement on the MEAP science test and it should not be generalized to other areas of the MEAP test such as language arts, mathematics and social studies. Because the data collected were from a specific point in time from Michigan schools whose instructors possessed specific certifications, the results from this study should not be generalized to other states' student populations at other points in time or location. Another limitation of the study is socioeconomic status data which was delimited to schools versus individual students. The reason for this was that access to individual student data was not available at the time of this study.

The sample of students was high school agriscience program completers selected from the Michigan high school agriscience student population. The reason for selecting high school agriscience program completers versus career and technical center agriscience program completers was that there was no feasible way in the framework of the study to discern MEAP science data of students enrolled at a career and technical center according to the available data sources of school building codes and MEAP science scores. The program completer data sources identified students by program and building code. For high school programs, the building codes were cross-referenced with the MEAP Science data sources. For career and technical center program completers, the MEAP Science data source was not accessible because each student's home school code was not available. Students of teachers with annual authorization were not included in the study as the available data source creates a unique, identifiable population of students due to the low number of teachers (n=1) who held annual authorization during the time period of the study and this would have compromised the confidentiality of the teacher and the students.

Definition of Terms and Acronyms

Agricultural Education – formal learning programs offered at the secondary level about agriculture and natural resources (Phipps & Osborne, 1988)

Agricultural Educator – formal instructor or teacher of an agricultural education program (Phipps & Osborne, 1988)

Agriscience Education – another term for agricultural education but with a stronger emphasis on science principles (Michigan Agriscience and Natural Resources Education, 2008)

Agriscience Program – a formal education program that focuses on the science and management principles of agriculture and natural resources at the secondary level (Michigan Agriscience and Natural Resources Education, 2008)

Annual Authorization – a temporary permission granted to teach a certain subject (Michigan Department of Education, 2008b)

ANR – Agriscience and Natural Resources (Michigan State University, 2008a)

Assessment – an evaluation given to determine mastery or knowledge (Linn & Gronlund, 2000)

Career and Technical Education – education that focuses on the integration of academics, skills and awareness of industry career opportunities (Association for Career and Technical Education, 2008b)

Continuing Education Unit – learning experiences offered instead of formal university education (Michigan Department of Education, 2008b)

Elementary and Secondary Education Act – originally enacted in 1965, this act was re-authorized by Public Law 107-110, also known as the No Child Left Behind Act, and strives to improve education in the United States through regular student assessment and certification standards for teachers (United States Department of Education, 2008b)

Emergency Authorization – granted permission to teach in situations where student learning is severely impaired by lack of qualified teachers (Michigan Department of Education, 2008b)

Experience Based Learning – student growth that occurs through participation in practical, real-world situations (Phipps & Osborne, 1988)

FFA – the National FFA Organization, formerly known as Future Farmers of America, an organization of students enrolled in agricultural education throughout the United States of America (National FFA Organization, 2008)

In-service Teacher – a teacher who is currently teaching (Myers & Dyer, 2004)

Leadership Development – the growth of students in the area of interpersonal skills (Michigan Agriscience and Natural Resources Education, 2008)

MDE – Michigan Department of Education (Michigan Department of Education, 2008a)

MEAP – Michigan Educational Assessment Program (Michigan Department of Education, 2008a)

National Council for Agricultural Education – an umbrella leadership organization of the key agricultural education organizations at the national level (National Council for Agricultural Education, 1989)

NCLB – No Child Left Behind Act, see Elementary and Secondary Education Act (United States Department of Education, 2008b)

Objectives – specific learning outcomes defined for students (Linn & Gronlund, 2000)

Post-secondary Education – learning above the high school level (Phipps & Osborne, 1988)

Pre-service Teacher – a teacher who is in the preparation stages before formal employment (Myers & Dyer, 2004)

Primary Education – learning at the kindergarten through 8th grade level (Linn & Gronlund, 2000)

Probationary Certification – certification granted to newly inducted teachers (Michigan Department of Education, 2008b)

Professional Certification – certification granted to teachers completing a combination of experience and additional training or education (Michigan Department of Education, 2008b)

Program Completer – a student who has completed a series of agriscience courses at a local agriscience program (Michigan Department of Education, 2008e)

SAE – Supervised Agricultural Experience also known as a project carried out by a high school agriscience student (National FFA Organization, 2008)

Science Integration – the incorporation of science into the agricultural curriculum (Thompson & Balschweid, 2000)

Secondary Education – learning at the high school level (Phipps & Osborne, 1988)

Single Teacher Program – agriscience program employing one teacher (Phipps & Osborne, 1988)

Student Performance – the measurable level of achievement demonstrated by a student (Linn & Gronlund, 2000)

Teacher Certification – the licensure granted to teachers by the state (Michigan Department of Education, 2008b)

Teacher Preparation – formal instruction provided to pre-service teachers at the university level (Michigan Department of Education, 2008b)

Vocational Education – see Career and Technical Education (Association for Career and Technical Education, 2008b)

CHAPTER 2 LITERATURE REVIEW

Introduction

The study focused on the relationship between agriscience teacher certification and achievement of Michigan high school agriscience program completers on the science test of the Michigan Educational Assessment Program. To better understand the literature related to the variables in this study, the researcher reviewed journal articles and publications related to the field of agricultural education, career and technical education, and the areas of science education, student achievement and teacher preparation.

The four strands of the review of literature focus on variables related to the study to provide insight into the trends and issues related to the body of knowledge in each area. The first section outlines trends in agriscience education and the focus on integrating science into high school agriscience programs. The second section provides information on trends in career and technical education, the response to federal educational mandates, and the efforts in delivering instructional strategies to students to improve academic achievement. The third section reviews research in the area of student achievement and teacher preparation. The fourth section reviews research of socioeconomic status and gender related to student achievement. The review of the literature provided the researcher with a foundation of knowledge on the variables investigated in the study, teacher preparation and qualifications, and their effect on science achievement by agriscience students. The terms describing agriscience programs vary based on the nomenclature of the authors.

Agricultural Education and Science Integration

The agricultural education literature documents research conducted on science integration, student achievement, teacher perceptions and teacher preparation. This research coincides with change in national educational policy and programs with the advent of No Child Left Behind. Educational accountability through measurable achievement of students is a driving force in the American educational system (United States Department of Education, 2008a).

A trend of declining enrollment in high school vocational agriculture programs from the late 1970s through the 1980s was caused by misconceptions about the scope of careers beyond production agriculture by students, increased graduation requirements, increased college admission requirements, changes in scheduling formats such as block schedules, and low interest in FFA (Doese & Miller, 1988). In response to these changes and challenges, the National Council for Agricultural Education (1989) developed the Strategic Plan for Agricultural Education to guide the future of agricultural education. This document outlined a plan to improve agricultural education at the national level. In response to changes at the national level, Michigan vocational agriculture programs were restructured in the late 1980s to incorporate more science education in the curriculum (Showerman, 1994) and became “agriscience” programs.

The following researchers have examined the integration of science into the agricultural education curriculum from multiple perspectives. Jones and Bowen (1998) reported agriscience programs that integrated technology and science into the curriculum enrolled more African American students when compared to production-based programs (Jones & Bowen, 1998). When conducting an assessment of science integration into Michigan high school agriscience programs, Connors and Elliot (1995) found no difference in scores on a high school science achievement test between two groups of students where one sample of students (n=49) was enrolled in an agriscience course and another sample of students (n=107) was not enrolled in an agriscience course. The population in the study (n=156) included seniors who had completed science requirements for graduation. Analysis of the effects of variables showed that science credits earned by the student and the students' overall grade point average were directly related to the score on the science achievement test (Connors & Elliot, 1995).

Chiasson and Burnett (2001) investigated all 11th grade students taking Louisiana's Graduate Exit Examination (N=31,497). They discovered that students enrolled in agriscience courses (n=2947) scored significantly higher overall scores in the area of science than the population of students not enrolled in agriscience classes (n=28,550). The agriscience students scored equal to, or greater than, the non-agriscience students on four out of five domains on the science test. The five domains were scientific method, biology, chemistry, earth science and physics. Chemistry was the only domain where agriscience students performed lower compared to the non-agriscience students. The data also showed that students enrolled in agriscience courses were more likely to pass the science test than those who were not enrolled in agriscience courses (Chiasson & Burnett, 2001).

A similar study conducted in Georgia by Ricketts, Duncan, and Peake (2006) targeted the population of high school agriscience students who completed two or more agriscience courses through a complete program that offered classroom and laboratory instruction, supervised agricultural experience and leadership development (N=3,482). The measure of performance in the study was achievement on the Georgia State Science assessment. The sample subjects (n=523) were enrolled in 23 different schools. Subjects were ranked by their teacher on a scale of involvement from “1” meaning not very involved to “5” meaning very involved. The findings showed that students achieved higher scores due to greater involvement in the total agriscience program compared to those who were not very involved in the total program. Data revealed slightly higher scores for students involved in other career and technical programs and just slightly lower than college preparatory students when measured by mean scores on the state science assessment. Data also showed a low positive correlation between science test scores and number of agriscience courses completed and a moderate positive correlation with overall participation in the total agriscience program. Recommendations included additional research in other states to highlight the correlation between agriscience program participation and achievement in science assessment in the areas of biological and physical science by agriscience students (Ricketts, Duncan, & Peake, 2006).

In a study of Oregon agriculture teacher attitudes and perceptions towards integrating science, Thompson and Balschweid (1999) found that almost half of the teachers reported that their agriscience students received science credit for agriscience classes, although only one in five teachers held a teaching endorsement in science. The data showed that more teachers felt prepared to teach biological science than physical science. Teacher participants (n=106) reported that parental and administrator support increased since the teacher integrated science but obstacles included lack of funding, equipment and training. The researchers recommended that agriscience teachers earn a science teaching endorsement if they planned on teaching more science in the agriculture curriculum (Thompson & Balschweid, 1999).

Additional research in Oregon by Warnick, Thompson, and Gummer (2004) included a study of Oregon high school science teachers in schools that had high school agriculture programs (N=360) during the 2001-02 year with a sample of the general population (n=214). Findings from the sample paralleled earlier data collected on agriculture teachers and continued to show funding, equipment and training as barriers to science integration in agriculture courses. In addition, 84% of the science teachers felt they could offer the agriculture program assistance compared to 74% who felt that the agriculture program could assist the science program. About half of the sample felt that the agriculture teacher was competent enough to teach science concepts. The study recommended that external funding sources be pursued to expedite science integration in agriculture programs. Over 96% of the science teachers generally perceived agriculture as an applied science. Over half of the sample felt that agriculture courses should receive science credit (Warnick, Thompson, & Gummer, 2004).

Dyer and Osborne (1999) reported that in a survey of counselors (n=19) at model student-teaching schools (n=16) in Illinois, schools with science integration in the agriculture program (n=11) were rated higher in quality than those without science integration (n=5). The survey evaluated counselor attitudes and perceptions at schools used as sites by the University of Illinois and Illinois State University (Dyer & Osborne, 1999). Dyer and Osborne's (1998) study of Illinois high school science teacher attitudes reported that high school science teachers who worked with an integrated agriscience course felt that the class merited laboratory science credit (Dyer & Osborne, 1998). A study by Johnson (1996) demonstrated strong support by Arkansas agriculture teachers for science credit for agriculture classes. He found that these teachers understood the need to strengthen the science focus in their curriculum. Thompson (1998) concluded in a study of FFA award winning agriscience teachers (n=187) that teachers believed science integration helped students learn the science of agriculture. The study also found that teachers taught more biological concepts than physical science concepts in their curriculum. Teachers felt that science integration would attract higher-ability students and improve the image of the agriscience program. The study recommended focusing on teacher in-service training in science integration and undergraduate education in this area (Thompson, 1998). In a demographic study of the same population of teachers, Thompson and Schumacher (1998) reported over 80% of the teachers had received training on science integration which coincided with nearly one-half of the teachers describing their program as integrated science. They also reported that about one-half of the teachers' courses were offered for science credit and that females were more likely to enroll in specialized courses that integrated science (Thompson & Schumacher, 1998).

An example of science integration into an agricultural program was described by Conroy and Walker (2000) where aquaculture helped students better understand mathematics and science concepts. The study recommended that agriculture teachers have the prerequisite knowledge and skills to teach science and to integrate science into the curriculum (Conroy & Walker, 2000). Thompson and Balschweid (2000) identified three themes of perceptions of agricultural science and technology teachers with regard to integrating science into the curricula. They found that most Oregon teachers had a positive attitude regarding science integration with supporting evidence that nearly one-fourth had a teaching credential in a science area, half of the teachers reported that their students received science credit for agricultural courses and that 84% of the teachers had professional development training on science integration. Data showed a greater understanding of biological science than physical science by agriculture teachers. Teachers also felt that additional training in science integration would assist pre-service teachers. In was also determined that teachers felt integrating science would better assist students in meeting state educational standards (Thompson & Balschweid, 2000). Further research in Oregon by Warnick and Thompson (2007) indicated that about one-third of agricultural science teachers are in a cooperative, collaborative situation which is impacted by time available for common planning and teacher motivation and desire to collaborate. The researchers urged the use of the survey instruments to replicate studies in other states and regions to sustain research on teacher attitudes and perceptions to help build further collaboration between agriculture and science teachers (Warnick & Thompson, 2007).

Balschweid and Thompson (2002) reported similar results in Indiana. Over 30% of 125 responses to an open-ended question on science integration indicated that science credit earned for completion of agricultural science classes was a motivating factor to integrate programs. The study found that 40% of Indiana teachers held a science endorsement and that over half of the teachers reported their courses received science credit. The teachers agreed that they were prepared to teach biological and physical science concepts but three barriers to integrating science were funding, equipment and training (Balschweid & Thompson, 2002). Myers and Washburn (2008) reported 71% of Florida teachers thought that science integration was necessary. As reported in previous studies, planning time, materials and funds were perceived barriers. Positive attitudes about student learning (94%) and problem solving (87%) pointed towards a desire to increase science integration but class size may be a limiting factor. The researchers also concluded that teacher behavior mirrors increased science integration (Myers & Washburn, 2008).

When assessing the priorities and challenges of agriscience teachers, curriculum and science integration do not rank as high when compared to other aspects of the total program of agriscience education. Myers, Dyer, and Washburn (2005) identified five top challenges facing agriscience teachers. These were: volunteer support and organization, advisory committees, FFA chapter management, student discipline and retaining alumni support. Science integration was not identified in the top five challenges nor the top 11 challenges utilizing a Delphi method (Myers, Dyer, & Washburn, 2005). Stewart, Moore, and Flowers (2004) used a Delphi technique to ask 15 agricultural industry leaders and 15 educational leaders to identify emerging industry and educational trends and their impact on agricultural education. The results identified curriculum as the fourth highest ranked issue, academic standards as eighth, accountability as 13th, and educational research as 19th. These findings are consistent with those presented by Myers, Dyer, and Washburn (2005). Budgets and finance were the highest ranked emerging issues. The researchers concluded that many of the trends overlap and are highly connected (Stewart, Moore, & Flowers, 2004).

High school agriscience programs that have integrated science into the program to be more science-based may realize benefits of the change according to Shelley-Tolbert, Conroy, and Dailey (2000). The main benefit of integrating more science is an enhanced image of agriscience programs that would attract higher performing students into the local program. Opinions varied as to the extent of the integration as the benefits of leadership development and supervised agricultural experience programs make the total program of agricultural education unique within the educational system (Shelley-Tolbert, Conroy, & Dailey, 2000). According to Wilson, Kirby, and Flowers (2002), teachers most likely to adopt a biotechnology course into the local agriculture program exhibit three specific traits. These were: fewer years of experience, attendance at biotechnology training functions, and perceived fulfillment of the local program in meeting student and community needs (Wilson, Kirby, & Flowers, 2002). Boone, Gartin, Boone, and Hughes (2006) shared descriptive analysis of a census population (N=95) on attitudes, knowledge and understanding of biotechnology by agriscience teachers in West Virginia. The researchers concluded that teachers were more familiar with topics related to agriculture than other fields such as environmental issues and human genomics. The researchers recommended curriculum delivery through in-service training, examination of content knowledge during teacher preparation and support from stakeholders of agricultural education (Boone, Gartin, Boone, & Hughes, 2006).

Additional research by Mowen, Roberts, Wingenbach, and Harlin (2007) on Texas agricultural science teachers' (n=274) knowledge and attitudes showed some general knowledge of biotechnology with more knowledge about production oriented topics like animal reproduction and less knowledge about science oriented topics such as electrophoresis. Significant relationships emerged between knowledge levels of topics and likelihood of inclusion of that topic in the classroom instruction. The researchers recommended that in-service activities target the areas where the least teacher knowledge exists (Mowen, Roberts, Wingenbach, & Harlin, 2007). The lack of research on teacher training, specifically placement of student teachers with collaborating teachers, is documented by Myers and Dyer (2004) in a synthesis of the literature on agriscience education teacher preparation programs (Myers & Dyer, 2004).

The literature related to science and agriscience education identified the trend of declining enrollment because of increased graduation requirements, scheduling and limited perceptions of the field of agriculture and changes in Michigan curriculum to integrate science into local programs in response to this trend. Researchers shared that perceived benefits of increased enrollment and diversity and better or equal scores on science achievement tests are benefits of increased science integration in agriscience programs. They also found that students more involved with the total program are more likely to achieve higher in science than those less involved.

Researchers in Oregon, Illinois and Indiana shared that science integration produces challenges such as time to integrate science, materials and funding. Science teachers and counselors generally supported agriscience programs that integrated science. Researchers found that beliefs of the benefits of science integration include improved image of the local program and inclusion of higher achieving students. They also found that biology was the area of science with the greatest correlation to agriscience curriculum and that additional science endorsements are needed by agriscience teachers integrating science in the agriscience curriculum.

Researchers recommended professional development for in-service teachers and additional training by pre-service teachers as methods to continue the integration process of science into agriscience curricula with emphasis on the life sciences. When analyzing priorities and challenges that agriscience teachers face, curriculum is important, but other facets of the total program of agriscience education compete for higher priority ranks.

The scholarship of the researchers was important to understand the historical context of the trend of science integration in agriscience programs. Identifying the benefits of science integration to students and local agriscience programs was needed to understand the impact curricular trends have on teacher certification, preparation and professional development. The research affects the structure of the study by illustrating the importance of the variable of teacher certification and science endorsement and the effect on student achievement in science.

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Career and Technical Education Trends

Career and technical education serves over 15 million students in over 11,000 high schools and over 1,400 career and technical centers and post-secondary institutions through hands-on learning, job placement and continuing education. Career and technical education links vocational skills with academic content by training the head and hands together and also serves as a bridge to post-secondary education (Association for Career and Technical Education, 2008a). Career and technical education professionals are unified by the Association for Career and Technical Education (ACTE) (2008b). The ACTE is composed of technical teaching areas such as industrial arts, business, home economics, marketing, technology, health and agriculture (Association for Career and Technical Education, 2008b).

Legislation such as No Child Left Behind and educational trends impacted career and technical education over the past several decades. For example, The Secretary's Commission on Achieving Necessary Skills (SCANS) Report from the United States Department of Labor (1992) identified three foundation areas for high school and college graduates – basic skills, thinking skills, and personal skills. Basic skills include speaking, reading, listening, writing and math. Thinking skills include creativity, decision-making, problem solving, visualization and knowing how to learn. Personal skills include responsibility, self-esteem, sociability, self-management, integrity, and honesty.

The researchers of career and technical education revealed responses from career and technical education and agriscience education programs to enhance the basic skills of students identified in the SCANS Report. Woglom, Parr, and Morgan (2005) reported that the 2003 science achievement scores of agriscience students (n=2275) on the Kentucky state high school science assessment were about equal in mean scores when compared to other career and technical education students (Woglom, Parr, & Morgan, 2005).

Career and technical education trends impact agriscience education as well. Conroy (2000) proposed a change in the conceptual model of agriculture careers within career and technical education systems to account for changing perceptions and preferences of careers related to agriculture, food and natural resources. The researcher shared the need to focus beyond entry-level and production-oriented careers and to also include careers with more science emphasis. The broader definition of careers in the agriculture, food and natural resources areas would provide skilled graduates to businesses within the local community. Changing educational policy at the federal level (United States Department of Education, 2008b) such as No Child Left Behind has also played a key role in molding the face of career and technical education today (Conroy, 2000).

Chadd and Drage (2006) conducted a survey of Illinois principals (n=123) and secondary career and technical education teachers (n=114) regarding their perception of the impact of No Child Left Behind on career and technical education programs. The researchers found that principals were in agreement that career and technical programs were beneficial to students and to achieving curriculum goals if they reinforced core academic standards. A majority of principals agreed that English language arts and mathematics could easily be incorporated into career and technical education programs. Principals did not agree with statements that claimed No Child Left Behind helps all students graduate or that the legislation had improved the image of career and technical education in their school. Open-ended responses by principals identified reduced course options for students and elimination of career and technical education programs due to limited funding as their primary concerns. The study also focused on the perceptions of career and technical education teachers. A majority of teachers agreed with the principals' beliefs that career and technical education helps teach language arts and mathematics and helps achieve graduation goals. Teachers disagreed with statements that career and technical education has improved their program's image as a result of No Child Left Behind. Teachers also responded to an open-ended question with limited course offerings as their primary concern. The key item principals and teachers differed on was effect of increased enrollment on career and technical education programs. Principals agreed that No Child Left Behind has increased career and technical education enrollments, whereas, teachers disagreed. The study concluded that teachers and principals agreed that career and technical education programs help students learn in the core subjects, reach high academic standards, and improve graduation rates. The researchers recommended that because federal mandates are data-driven, states should examine the effects of career and technical education and its role in meeting federal mandates through data collection and analysis (Chadd & Drage, 2006).

Teitelbaum (2003) conducted a study investigating the impact of higher number course requirements for graduation in the areas of mathematics and science. The study included high school graduates (n=5586) with transcript data from 732 high schools throughout the United States. The findings revealed that increased requirements in the required number of science and math courses for graduation increased the number of courses that students completed but did not achieve the goal of increased science and math achievement scores. Variables that may have contributed to this are the academic level of the courses completed and schools not enforcing the graduation requirements (Teitelbaum, 2003).

Edwards (2004) conducted a review of the literature in cognitive learning, student assessment and instruction. He discovered that these aforementioned constructs are investigated in agricultural education but they are not integrated into current educational trends. He cited numerous studies involving descriptive and causal-comparative research but recommended that more experimental design research be conducted with current educational priorities in mind based on his literature review (Edwards, 2004).

Hoachlander (2007) called for academic standards, assessment and integration of academics into career and technical education. While the agricultural education literature has few citations in the area of reading instruction, Park and Osborne (2007) describe a model for the study of reading in agriscience. They describe the added pressure for agriscience education to meet the core academic standards and improve student achievement through reading. The researchers described how teachers influence reading through attitudes and knowledge and use strategies to engage the student, improve the reading environment and understand the text. They pointed out that reading in agriscience uses specialized vocabulary and content. The researchers indicated the small amount of research in the literature of agricultural education and recommended research on the affects of reading instruction, teacher attitudes and instructional strategies (Park & Osborne, 2007). O'Reilly and McNamera (2007) found in a study of high school students (n=1,651) that reading skill and strategy had a positive correlation in predicting success on science achievement tests (O'Reilly & McNamera, 2007).

Teacher certification is an integral part of the current educational model. McCaslin and Parks (2002) identified teacher licensure and regulation as one of four major parts of career and technical education teacher preparation. Other areas included subject matter knowledge, pedagogical knowledge and field experience, also known as student teaching (McCaslin & Parks, 2002). Further review of the literature related to teacher certification was documented. In response to the effects of No Child Left Behind, Martin, Fritzsche, and Ball (2006) conducted a Delphi study of Illinois agriculture teachers and in-service teacher preparation professionals (n=20). The results of the study identified that a key concern was in the area of developing "highly-qualified" agriculture teachers. “Highly-qualified” was described by the No Child Left Behind Act (United States Department of Education, 2008b) as teachers who have met qualifications to teach a subject area by passing a state-administered subject area test. The researchers identified this as a disadvantage to agricultural education programs already faced with a teacher shortage and a higher percentage of under-certified teachers who do not meet the legislation’s requirements. They identified a major implication was agricultural education programs need to be aligned with core curricular areas in order to validate the importance of their role in the educational system. The authors recommended additional certification in science subjects to be a significant advantage to agriculture teachers offering agriculture courses for science credit (Martin, Fritzsche, & Ball, 2006).

Research in the area of career and technical education supports the efforts of career and technical teachers serving who work to educate the “whole person” as well as teach technical knowledge to millions of students. Changes in federal law such as No Child Left Behind have driven career and technical education programs to integrate core subjects such as language arts, mathematics and science into their curricula in order to remain as viable components of educational programs. Researchers found that core curriculum standards are met through career and technical education where core academic areas are integrated into career and technical programs. Core areas included mathematics, science and language arts. Reading competency was identified as having a positive correlation with achievement on student assessments. Additional experimental research on cognitive learning strategies and student achievement was recommended.

Researchers recommended an expanded focus on careers beyond entry-level positions to include those that are science-oriented. Teacher certification was relevant in integration efforts as “highly qualified” definitions have led to teacher shortages in some parts of the country. Researchers recommended that career and technical education teachers have additional teaching certifications to be better positioned to teach core academic areas within career and technical programs.

The review of literature on career and technical education trends was important to understand the parallel between integration of core academic areas in career and technical education and the integration of science into agriscience programs. Federal educational policy impacts career and technical education in the areas of curriculum and teacher certification. The researchers recommended additional academic endorsements for career and technical teachers which is an underpinning of the design of this study analyzing agriscience student achievement in the academic area of science. In this study, agriscience programs with science integration are included and have teachers with additional endorsements in an academic area.

Student Achievement and Teacher Preparation

Research beyond the scope of agriscience education shared different perspectives on the constructs of student achievement and teacher preparation. Venville, Wallace, Rennie, and Malone (2000) revealed the absence of research on how math and science is learned in integrated settings. Yasumoto, Uekawa, and Bidwell (2001) found collegial efforts and a team focus in instructional practices improved student achievement in mathematics and science. They concluded that a team focus within content areas, where teachers identified and addressed problems and issues as a team, helped provide consistent instruction within math and science. They found that 16% of the variance in student achievement in math and science was related to departmental efforts.

Researchers of instructional practices related to scientific instruction describe conclusion and recommendations related to science achievement. Jorgenson and Vanosdall (2002) reported a majority of kindergarten through eighth grade teachers lecture about science. They advocated hands-on science where students are actively involved in posing questions and designing experiments (Jorgenson & Vanosdall, 2002).

Huffman, Thomas, and Lawrenz (2003) studied middle school mathematics and science teachers (n=198) utilizing survey data to analyze the relationships among professional development, instructional strategies and student achievement. Data on hours of professional development and instructional strategies were compared with data on eighth grade achievement tests. They found 35% of the variance was explained by science teacher's focus on curriculum development and examining their practices. The researchers concluded that the affect of professional development on student achievement was difficult to research as variables contributing to its effectiveness are complex (Huffman, Thomas, & Lawrenz, 2003).

Eberle (2008) conducted a quasi-experimental study on the beliefs and practices of middle school science teachers (n=6). The researcher found that beliefs about coherent, connected scientific thoughts did not equate with coherent teaching strategies and coherent scientific content. The researcher presented a tri-partite curriculum model that illustrated the flow of intended thoughts to attained goals. The researcher implied that scientific knowledge is important, but teachers need training in pedagogy to achieve results in student learning (Eberle, 2008). Lack of training in pedagogy during pre-service training may be linked to inservice practice. Research on pre-service practices by Windschitl and Thompson (2006) included a qualitative study of pre-service teachers (n=21) at a Northwest university who were participants in a two-part course on science teaching methods. They found that extended instruction on scientific models helped pre-service teachers be more effective in teaching scientific principles (Windschitl & Thompson, 2006). Anderson (2000) described concept maps as a lesson plan tool to teach pre-service teachers science concepts more effectively.

Other research on in-service training included Garet, Porter, Desimone, Birman, and Yoon (2001) who conducted a survey on in-service teachers (n=1,027) and their self-reported improvement in knowledge and skills. They found three types of professional development activities were preferred. The first type was training that focused on content information. The second type was active learning defined by teachers having the chance to observe teaching methods, model those methods and receive feedback. The third type of professional development was training that provided coherence and connectedness to knowledge and strategies. The researchers also determined that three features of professional development were preferred. One feature was time, where longer periods and more contact hours of inservice activities had a positive relationship with self-reported improvement. Time span measured in days and number of inservice hours had a substantial positive relationship with active learning of teachers and a minimal positive relationship with coherence of subject matter knowledge. The researchers found traditional professional development focusing on the preferred types and features had positive relationships with improved teacher knowledge and practice (Garet, Porter, Desimone, Birman, & Yoon, 2001).

In the literature of agricultural education and teacher preparation, Myers, Washburn, and Dyer (2004) conducted a study to establish baseline information on the knowledge and ability of agriculture teachers to teach scientific process skills. Their review of science literature identified these process skills as an effective way to teach science. The study included an accessible sample of teachers (n=38) with an interest in science who also attended a workshop on integrating science in agriculture programs. The data revealed that regardless of training, 89% of the responses on a teacher assessment focusing on these skills were correct. No comparison data was available on science teachers traditionally trained. Five of the teachers in the sample held endorsements in science and agriculture. No significant differences among learning style, gender, certification area, years of experience or gender in the sample were found. The researchers concluded that the teachers were qualified to teach scientific principles based on the results of the teacher assessment (Myers, Washburn, & Dyer, 2004).

At different levels in education, teacher certification had significant impacts. Wayne and Youngs (2003) identified degrees and certification status as two of four variables that positively impacted student achievement. Laczko-Kerr and Berliner (2002) conducted an ex-post-facto study investigating the impact of under-certified teachers in Arizona (n=218). The data showed significant negative impacts on student achievement in the population served by the under-certified teachers. The students of certified teachers had about 20% more academic growth than the population of students served by under-certified teachers. The researchers recommended continued support for state certification processes but offered criticisms of certain measures such as teacher competency testing because of limited research validating its effect on enhanced student learning (Laczko-Kerr & Berliner, 2002).

Graham and Garton (2003) reported that the best indicator of teaching success as reported by teacher supervisors was agricultural education coursework grade point average. They cautioned that over 60% of the variance was not explained and there were other variables that explain teacher success. The study included teachers certified through traditional pathways and did not include teachers certified through alternative pathways (Graham & Garton, 2003).

Lumpe (2007) argued that while sociological factors such as gender and socioeconomic status affect student achievement, science educators were urged to conduct research of best practices for teacher preparation to improve student science achievement and learning. Darling-Hammond (1997) reported that instructional skills and knowledge about subject matter of teachers impacted student achievement significantly. Solorzano (1998) reported the negative impact of under-qualified teachers as measured by lower academic gains on achievement tests of minority students. Goldhaber and Brewer (1998) found that most public school teachers hold undergraduate degrees, but nearly one-third do not have a degree within their teaching area. Specifically, the study examined science achievement of 8^{th} and 10^{th} grade students and found that advanced degrees germane to the subjects were effective (Goldhaber & Brewer, 1998).

Hawk (1985) reported that certified mathematics teachers had greater subject matter knowledge, implemented better instructional strategies and had students who performed better than non-certified mathematics teachers. Goldhaber and Brewer (2000) found students with teachers who received training and certification within mathematics had significantly higher academic performance on achievement tests in mathematics than students with teachers without mathematics training and certification. The research was based on a longitudinal study with a data set of 6,310 students (Goldhaber & Brewer, 2000).

When comparing factors such as class size, teacher preparation and curricula and their impact on student achievement in California, class size impacts were small but the effects of teacher preparation and curriculum vary significantly in schools where more disadvantaged students received fewer highly qualified teachers ("School Resources and Student Outcomes", 2001). Another study in California by Felter (1999) revealed the shortage of qualified mathematics teachers in 795 high schools was associated with low student achievement (Felter, 1999). Moreau (1987) reported a positive significant correlation between highly qualified teachers employed and larger school systems.

In conclusion, team efforts were necessary for success in integrated curricular studies. Scientific instructional practices included lecture, but hands-on and experimental research were more crucial in teaching process skills to students. Student achievement variance was complex, but some variance was explained by professional development and instructional strategies. Research also revealed that beliefs about scientific instructional do not always mirror practice. Pre-service training affects in-service practices such as teaching science processing skills. The negative impact of under-certified teachers was outlined and supported by research on the knowledge level of teacher and its relationship to achievement of students in core areas.

The studies in the review of literature related to student achievement and teacher preparation were important to this study to better understand the role of hands-on and experimental research in teaching science, skills which agriscience teachers were found to possess regardless of training. This was related to understanding the variable of teacher certification, a direct result of teacher pre-service and in-service training. The researchers also found that instructional strategies and professional development are related to student achievement in science. It was important to consider that pre-service training impacts in-service practice in teaching science and that professional development influences teacher practice.

Socioeconomic Status, Gender and Student Achievement

Chiu and Khoo (2005) documented the literature related to socioeconomic status and identified income and resources as significant variables in student achievement. Fagan and Ponder (1981) concluded that teacher qualifications and student socioeconomic status were not significantly correlated to the achievement of the general school population. However, these two variables were significantly correlated to student achievement in low-achieving schools. The impact of socioeconomic status on student achievement has been documented under different geographical areas and across educational systems. Muller, Stage, and Kinzie (2001) reported that socioeconomic status and previously earned grades was a strongly positive factor in determining 8^{th} grade science achievement across gender and ethnic subgroups. Quantity of coursework in science classes was the key factor in science achievement in high school across all subgroups in the study. The study (n=5,708) included African-American, Asian-American, Latino and Caucasian subgroups (Muller, Stage, & Kinzie, 2001).

Fram, Miller-Cribbs, and Van Horn (2007) determined from a longitudinal study of elementary students in Louisiana (n=3,501) that economically disadvantaged students tended to be concentrated in a subset of public schools. These students tended to be concentrated because of factors such as the mother's education level and family structure. They found that nearly 80% of the variance in reading achievement was contributed to factors linked to socioeconomic status (Fram, Miller-Cribbs, &Van Horn, 2007). Caldas and Bankston (1997) revealed a relatively strong correlation (r = .475) between poor students and schools with peers who were also poor. They also found that students who were in poverty tended to perform lower in academic achievement regardless of race. The researchers concluded that academic achievement gains were difficult to achieve in settings where students were severely economically disadvantaged. Rothstein (2008) supported the argument that decreasing academic achievement gaps must be linked to reforms that decrease socioeconomic gaps. Glass (2008) indicated that the population of students in the United States was changing as more students who were poor also had a language barrier.

Milne and Plourde (2006) revealed in a qualitative research study that students from low-socioeconomic households had four common themes in achieving higher academic success. The first was educational resources such as books and parental help. The second was the mother's educational level and her respect and desire for further education. The third theme was supportive relationships such as a mentor. The fourth was a desire to achieve success as a result of further education (Milne & Plourde, 2006).

Dalton, Ingels, Downing, Bozick, and Owings (2007) reported results analyzing three longitudinal studies from 1982, 1992 and 2002. They revealed that the number of science credits earned by students in the lowest socioeconomic status quartile increased, on average, from 1.9 to 2.6 credits. They also revealed that the number of lower-level science courses completed by students in the lowest socioeconomic status quartile decreased and the number of higher-level courses completed increased (Dalton, Ingels, Downing, Bozick, & Owings, 2007).

Calls for sensitivity to gender bias in mathematics and science instruction urged educational leaders to work with teachers to create an equitable teaching environment to encourage females to pursue careers in mathematics and science (Berube & Glanz, 2008). Jovanovic and King (1998) found in a study comparing gender differences and science ability perceptions that females had lower self-perception. Burkham, Lee, and Smerdon (1997) found gender gaps in science achievement in continued research from the National Educational Longitudinal Study. Their recommendation was to increase the amount of laboratory experiences to close the gender gap in science at the high school level (Burkham, Lee, & Smerdon, 1997). Johnson, Wardlow and Franklin (1998) found opposite results in their study. Their study of Arkansas agriscience students (n=132) showed higher physical science test scores by females than males on immediate and delayed post-test assessments with no significant effect of instructional method. They cited previous research that documented higher science achievement by males, whereas, their study showed opposite findings (Johnson, Wardlow, & Franklin, 1998).

The review of literature on socioeconomic status and gender is important to this study because socioeconomic status and teacher qualifications had a greater impact in low socioeconomic schools. Income and resources were found to be significant in student achievement as schools in poverty areas documented lower performance. This variable is relevant to the analysis in this study because agriscience programs in Michigan serve a multitude of different communities that differ by socioeconomic status.

Achievement gaps between males and females were identified in longitudinal studies but changes in curriculum and instructional strategies reduced achievement gaps and, in some studies, reversed achievement gaps, especially in the area of agriscience education. This is important to the design of this study because agriscience programs serve male and female students and analysis of the variable of gender may lead to significant effects of this variable as documented in the literature.

Summary

A synthesis of the literature in teacher certification, agricultural education, science achievement and teacher preparation, and socioeconomic and gender effects on student achievement in science supports investigating the relationship between teacher certification and student achievement in science for high school agriscience students. Trends in agricultural education and career and technical education indicate that improved student learning in the core academic areas by agriscience students may improve the educational system and validate the role of agriscience education. Teacher preparation and certification are key variables that positively impact student learning and achievement in science. The variables of gender and socioeconomic status are included in the study based on the effects of socioeconomic status and the effects of agriscience education on closing achievement gaps between genders.

CHAPTER 3 METHODOLOGY

Purpose

The purpose of this study was to investigate relationships between agriscience education student achievement in science and agriscience teacher certification. In order to better understand existing teacher certification impacts, evidence must show the effect of certification on student achievement in science. Factors such as gender may impact student achievement, in addition, the study will also consider the socioeconomic status of the student's school district as a confounding variable.

Research Objectives and Hypotheses

The objectives of the study supported the underlying purpose of the study. Specifically, the five key objectives were to:

1. Identify the Michigan population of agriscience teachers and classify their teaching certificate type and certification areas;
2. Identify completers of high school agriscience programs and determine their categorical score and raw score on the MEAP science test and compare the agriscience program completer population to the general population;
3. Investigate the socioeconomic status of the schools included in the study and use in analysis as a confounding variable;

4. Investigate the relationship between teacher certification and student achievement in science on the MEAP science test measured by raw scores and also analyze the variables of gender and socioeconomic status; and
5. Investigate the variables of teacher certification, gender and socioeconomic status on the MEAP science test measured by placement level.

For testing purposes, null and alternate hypotheses were developed for testing purposes. The hypotheses outlined were non-directional. The null hypotheses for research objectives two, three, four and five were:

$H_{0(2)}$ There is no difference in mean scores of the agriscience program completer population and the general student population as measured by achievement in MEAP science test scores.

$H_{0(3)}$ There is no difference in the MEAP science test scores of the agriscience program completer population based on socioeconomic status.

$H_{0(4)}$ There is no difference in mean scores of the agriscience program completer population sub-groups delineated by gender and teacher certification as measured by achievement in MEAP science test raw scores.

$H_{0(5)}$ There is no difference in log odds of science level placement of the agriscience program completer population sub-groups delineated by gender and teacher certification as measured by MEAP science test placement level.

The alternate hypotheses for research objectives two, three, four and five were:

$H_{1(2)}$ There is a difference in mean scores of the agriscience student sample population and the general student population as measured by achievement in MEAP science test scores.

$H_{1(3)}$ There is a difference in the MEAP science test scores of the agriscience program completers population based on socioeconomic status.

$H_{1(4)}$ There is a difference in mean scores of the agriscience student sample population sub-groups delineated by gender and teacher certification as measured by achievement in MEAP science test scores.

$H_{1(5)}$ There is a difference in log odds of science level placement of the agriscience program completer population sub-groups delineated by gender and teacher certification as measured by MEAP science test placement level.

For testing purposes, the hypotheses were diagrammed μ_1 to represent the general population, whereas, the sample population is diagrammed μ_2 in the study:

$H_{0(2,3,4,5)}$ $\mu_1 = \mu_2$

$H_{1(2,3,4,5)}$ $\mu_1 \neq \mu_2$

Research Design

This study utilized a causal-comparative design. When considering the hypotheses for the study, the null hypotheses were that no relationship exists between teacher certification, socioeconomic status and gender (independent variables) and agriscience program completer achievement on MEAP science assessment (dependent variable). The alternative hypotheses were that a relationship exists between the independent and dependent variables. Because an experimental design would be impractical in manipulating the variables to answer this question, the causal-comparative design was the best fit for the study (Raudenbusch, 2008). A correlation study was not in order because there is only one dependent variable and categorical data was used in the analyses throughout the study (Ary, Jacobs, & Razavieh, 1996). A challenge related to causal-comparative design is that randomization does not occur as it would in experimental design (Bernard, 2002). In this study, two groups were formed for the independent variable (teacher certification categorized as provisional or professional) and the two groups were compared on the dependent variable (science achievement).

According to the literature, the effect of socioeconomic status plays a role in student achievement. To address controlling for this confounding variable, the study included socioeconomic status as a variable to include in analysis. To further address control issues with this design, the study compared homogenous subgroups of the entire population of agriscience program completers. In this study, the population was limited to high school program completers of single teacher agriscience programs in Michigan high schools where programs exist. Another homogenous subgroup comparison strategy was to compare student gender.

Instrument

The main instrument (Appendix A) was a database to collect demographic data from the Michigan Department of Career Development on completers of agriscience programs from the academic years of 2003-04 and 2004-05 in Michigan. This instrument provided Michigan Department of Education school district codes and high school building code number along with a unique student identification number. The instrument also included data on student science scores and placement levels from the Michigan

Education Assessment Program housed by the Michigan Department of Education's Office of Educational Assessment.

Teacher certification type was coded as "1" used to identify professional certificate holder and "2" used to identify provisional certificate holder.

Another key part of the instrument was socioeconomic status of the school of each subject in the study using the *School Matters* website of Standard and Poor's defining socioeconomic status as the percentage of economically disadvantaged students (Standard and Poor's, 2007). Student gender was coded with "1" for identifying male and "2" for identifying female.

The high school agriscience program completer data collected from the Michigan Department of Labor and Economic Growth was cross-referenced with Michigan Department of Education MEAP science achievement scores in the form of raw scores and scale scores derived from the raw, numeric score. A database of high school agriscience teachers and certifications they held during the time period of the study was collected from the Michigan Department of Education agriscience certification officer. Additional cross-referencing with socioeconomic status data from Standard and Poor's completed the data collection instrument. These data were listed as numerical percentages and defined as the percentage of economically disadvantaged students within each high school.

Population of Subjects

The sample population data included test scores from completers of agriscience programs in Michigan high schools who completed the MEAP science test from the

2003-2004 and 2004-2005 academic years (N=593). This sample was drawn from the population of all Michigan high school students (N=65,535) who completed the MEAP science test during the same time period. The agriscience program completer population was limited to Michigan high schools with agriscience programs. Agriscience program completers from career and technical centers were excluded from the sample population due to collection limitations of the available data sources.

Agriscience teacher certification types were determined by cross-referencing students' building codes with teacher certification codes from the Michigan Department of Education. The population of Michigan high school agriscience teachers with program completers used for investigation in the study was composed of single-teacher programs (N=61).

Human Subjects Committee

Because this study involved the use of data from human subjects, the Purdue University Institutional Review Board responsible for research on human subjects was involved with this study. The Purdue Human Research Participants' Protection Program Institutional Review Board application was submitted June 7, 2006 and was approved with exemption status on June 15, 2006 with IRB Protocol #0606004060 renewed on May 29, 2007, and May 27, 2008 (Appendix B). The Michigan Department of Education provided approval for MEAP science data access on August 14, 2006 (Appendix C). The Michigan Department of Labor and Economic Growth Office of Career and Technical Preparation data security agreement was signed on September 11, 2006 (Appendix D).

The data security agreement was a professional agreement put in place to understand the limits of access to student data and to protect confidentiality of the subjects in this study.

Data Collection

Working with the various agencies involved in the assimilation of the necessary data was straightforward but complex and time-consuming. The researcher encountered a number of obstacles such as different data management policies from different state agencies and personnel changes due to state budget restraints. The Michigan Department of Labor and Economic Growth Office of Career and Technical Preparation housed the necessary demographic data on program completers. A request with Human Subjects Approval was submitted and approved on September 11, 2006 by the Director. The data included a list of all agriscience program completers for the time period of the study. Primary information included a Unique Identifying Code (UIC) number for each student. Other data gathered included gender, school district code and building code.

The Michigan Department of Education Office of Educational Assessment housed the data on student science scores from the Michigan Education Assessment Program. Upon approval on August 14, 2006, the Manager of General Assessment provided access to science test score information including test cycle, science raw score defined as numerical data, and science placement level defined as categorical data. The data on the program completers was cross-referenced with the science test score data to create a database of 593 students. Numerical data expressed as raw scores on the MEAP science test determined the categorical data expressed in four levels on a scale of “1” through “4” with “1” representing highest proficiency and “4” representing lowest proficiency.

In order to classify the certification types of the teachers in the study, a request for a cumulative list of teachers and certification types for the 2003-04 and 2004-05 school years was submitted and approved by the Michigan Department of Education Agriscience Education Certification Officer. The certification types in this study were classified as provisional, professional or annual authorization. In the annual authorization category, too few subjects (n=3) and teachers (n=1) created a unique, identifiable sub-population and were not included in the study due to confidentiality reasons. This action reduced the sample from 596 to 593 students. No subjects were classified in the emergency authorization category, a special certification used by the Michigan Department of Education where teachers are authorized to teach in teacher shortage areas (Michigan Department of Education, 2008b).

The researcher considered the literature (Roberts & Dyer, 2004) on the variable of alternative-certified agriscience teachers versus traditional, professional-certified agriscience teachers on agriscience student achievement in science assessment. Rocca and Washburn (2006) posed a similar question in their study of Florida agriscience teachers classified as either traditionally certified or alternatively certified (n=66). The population of agriscience teachers in this study was certified through traditional procedures which did not justify analysis of the variable of alternative certification procedure at this point in time.

The Standard and Poor’s website was used to determine the socioeconomic status of each school included in the study (Standard and Poor’s, 2007). The status was defined as the percentage of economically disadvantaged students in the building. Upon completion of the classification of teacher certifications and indexing of socioeconomic status by school, the data set was cross-referenced with the building code data for each student to create a dataset that included student identification code along with their gender, raw science scores, science proficiency classification, teacher certification type and school socioeconomic status.

Data Analysis

Statistical analysis procedures were used using the Statistical Package for Social Science (SPSS v. 15, 16 and 17) in consultation with the Purdue University Statistical Consulting Services with an initial consultation in August, 2006, with follow-up consultations in February, 2007, and July, 2008. Because the null hypothesis was non-directional, a two-tailed t-test with alpha set *a priori* at 0.05 was used to compare the mean science score of the agriscience program completer population in the study (N=593) with that of the general population (N=65,535) of Michigan high school students taking the MEAP science test during the same period. Analysis of variance (ANOVA) was used to analyze numerical science scores while ANOVA for ranks was used to analyze categorical science score data. The alpha level was set *a priori* at 0.05 for the research objectives.

CHAPTER 4 RESULTS

This study investigated the relationships between science achievement by Michigan high school agriscience program completers and agriscience teacher certification. The population was 593 high school agriscience program completers in high school programs whose teachers were certified at the provisional or professional level. The science achievement data were the test scores of the Michigan Education Assessment Program (MEAP). To collect and analyze science test score data, the researcher accessed Michigan Educational Assessment Program science test score data from the Michigan Department of Education Office of Educational Assessment and Accountability for the time period the 2003-04 and the 2004-05 academic years.

The science test scores were in the form of raw scores and categorical scores. The MEAP Science test was comprised of 58 multiple-choice questions and a written, constructed-response question covering the content areas of scientific method and also earth, physical and life sciences. The areas of physical, earth and life sciences had 13, 15, and 13 questions, respectively. Scientific method questions totaled 17 questions. The raw scores were scaled and the scaled scores were classified into levels (Michigan Department of Education, 2008f). For the testing cycles of Spring 2004 and Spring 2005 included in this study, MEAP Science scores were classified into four levels (Michigan Department of Education, 2008a):

- Level 1 is *Endorsed and Exceeded Michigan Standards* with raw scores of 637, a maximum of 1137 was possible on the assessment.
- Level 2 is *Endorsed and Met Michigan Standards* with a score range of 530 – 636.
- Level 3 is *Endorsed at Basic Level* with raw scores of 500 – 529.
- Level 4 is *Not Endorsed* with scores of less than or equal to 499.

The sample included Michigan high school agriscience program completers (n=593) and Michigan agriscience teachers (n=61) during the time period of the study including the academic years of 2003-2004 and 2004-2005. The following sections are organized into different analytical areas of the study. The first results section describes the population of students and teacher certifications in the study. The second section shows the relationship between teacher certification, socioeconomic status, gender and student achievement in science by using the Analysis of Variance (ANOVA) statistical method. The third results section describes analysis of the categorical variables of proficiency level on the test and their relationships with teacher certification, socioeconomic status and gender derived from the ANOVA for ranks statistical method.

Research Objectives #1 and #2: Teacher and Student Demographics

The first two research objectives were to:

- Identify the Michigan population of agriscience teachers and classify their teaching certificate type and certification areas;

- Identify completers of high school agriscience programs and determine their categorical score and raw score on the MEAP science test and compare the agriscience program completer population to the general population;

The population of agriscience teachers was classified as professional or provisional by certification type. When cross-referenced with school building and student codes, the student population had 60.4% of subjects (n=358) with an agriscience teacher holding a professional certificate and 39.6% of subjects (n=235) with an agriscience teacher holding a provisional certificate. A majority of agriscience teachers possessed a science minor (n=59). This met the first research objective.

The number of subjects in the general population was 65,535 and the agriscience program completer population was 593. The mean science score for the general population was 529.68 with a standard deviation of 59.39 (M = 529.68, SD = 59.39) versus the study population with a mean science score of 526.13 and a standard deviation of 50.13 (M = 526.13, SD = 50.13). Both the general and agriscience program completer populations had a median of 528. The general population had a spread of 794 versus the agriscience program completer population with a spread of 302. The general population had a minimum score of 69 and a maximum score of 863. The agriscience program completer population had a minimum of 387 and a maximum of 689.

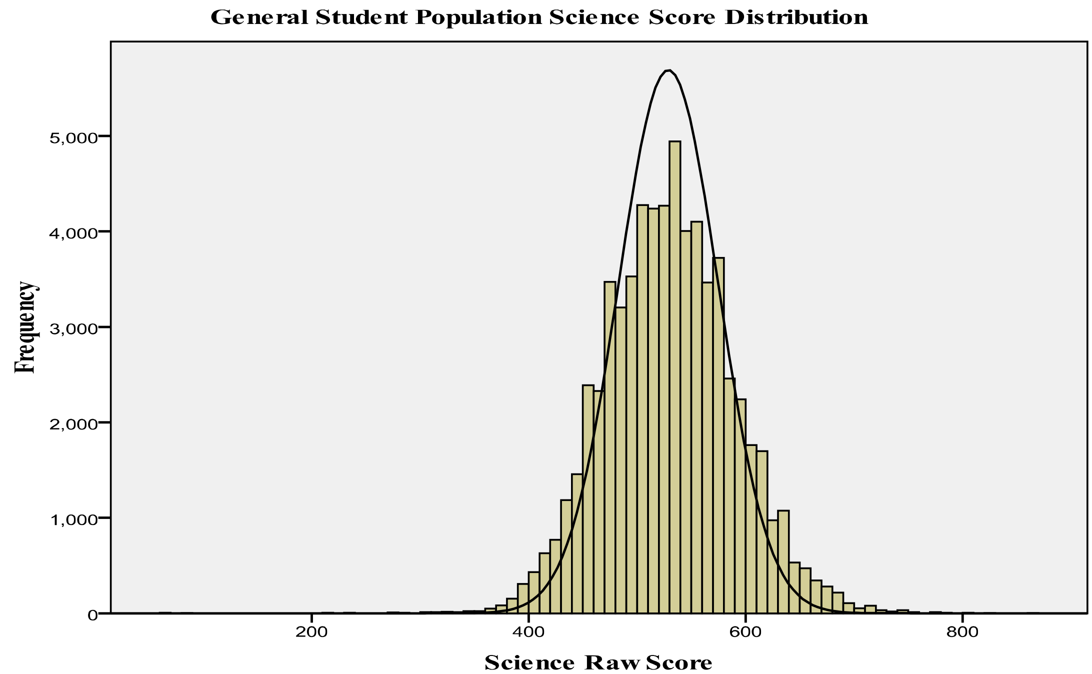
Descriptive statistics of the general population of students and the agriscience program completer population who took the Michigan Educational Assessment Program science test during the 2003-04 and 2004-05 years are listed in Table 1.

Table 1

MEAP Science Achievement Test Descriptive Statistics of Michigan High School Students

Statistic	General Population	Agriscience Program Completers
	N = 65535	N = 593
M	529.68	526.13
Mdn	528	528
SD	59.39	50.13
Range	794	302
Minimum	69	387
Maximum	863	689

Histograms organizing the distribution of science scores were created to show the frequency of scores for the general population and the agriscience program completer population. Figure 1 shows the frequency of scores for both populations with science raw scores on the x-axis and frequency on the y-axis. When comparing the distribution of scores on the histogram, both populations showed a symmetric, unimodal distribution. It is important to discern if score distribution in the agriscience program completer population is similar to the distribution of scores within the general population. The frequency distribution was included to illustrate that the agriscience program completer population was similar to the general population in distribution of scores.



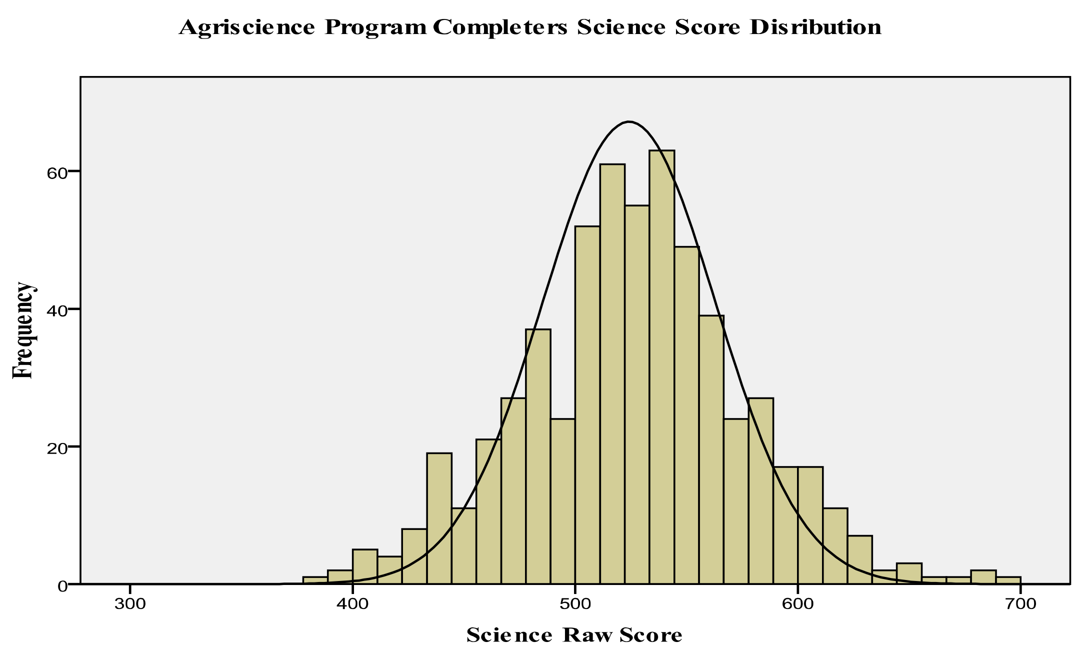


Figure 1. MEAP Science Achievement Test Score Frequencies of Michigan High School Students

Additional analysis of the placement levels determined by the raw science score showed that: 1.5% were classified as Level 1, 47.4% were classified as Level 2, 24.3% were classified as Level 3, and 26.8% were classified as Level 4 (see page 49). The agriscience program completer population was 49.9% male (n=296) and 50.1% female (n=297). The agriscience population had 60.4% of the subjects (n=358) with teachers holding professional certificates and 39.6% of the subjects (n=235) with teachers holding the provisional certificate. The demographic data is presented in Table 2.

Table 2

MEAP Science Achievement Test Demographics of Michigan High School Students

	General Population		Agriscience Program Completers	
	Number	%	Number	%
Science Placement				
Level 1	2,547	3.9	9	1.5
Level 2	30,100	46	281	47.4
Level 3	12,785	19.5	144	24.3
Level 4	20,103	30.6	159	26.8
Male			296	49.9
Female			297	50.1
Professional Certification			358	60.4
Provisional Certification			235	39.6

A two-tailed t-test was conducted to determine if there was a statistically significant difference in mean science scores between the general population and the Michigan agriscience program completer population. This was the appropriate analysis method as mean differences were being investigated and also because the hypothesis for the study was non-directional. The general population test score mean (*M* = 529.68, *SD* = 59.39) was not significantly statistically different from the agriscience program completer population test score mean (*M* = 526.13, *SD* = 50.13), *p* = 0.9253 (two-tailed). Table 3 is a summary of the two-tailed t-test. Based on the statistical analysis, the alternate hypothesis was rejected and the null hypothesis was retained for research objective 2.

Table 3

MEAP Science Achievement Test Two-tailed t-test Between the General Overall Population and Michigan Agriscience Program Completers

	General Population	Agriscience Program Completers	Difference
Population	N = 65535	n = 593	
M	529.68	526.13	3.55
SD	59.39	50.13	59.31
t	8.91	10.49	0.06
df	65,534	592	66,126
95% Confidence Interval			
Lower Bound	413.28	427.68	-112.70
Upper Bound	646.08	624.58	119.80
P-value	4.84E-19	9.50E-24	0.9523

Research Objectives #3 and #4: Variables and Science Achievement

The third and fourth research objectives were:

- Investigate the socioeconomic status of the schools included in the study and use in analysis as a confounding variable;
- Investigate the relationship between teacher certification and student achievement in science on the MEAP science test measured by raw scores and also analyze the variables of gender and socioeconomic status

To meet the research objectives, socioeconomic status data was defined as the percentage of economically disadvantaged students within the school that each agriscience program completer attended. These data were used to analyze the confounding variable of socioeconomic status on science test achievement using the Analysis of Variance (ANOVA) method. Along with socioeconomic status data, analysis of the interactions among the agriscience program completer population's science achievement, gender and teacher certification using ANOVA was completed. This was selected as the best statistical method to use because ANOVA simplifies multiple comparisons that could also be completed with multiple t-tests. ANOVA reduces the chance of committing a Type I error which is more probable when multiple t-tests are performed (Howell, 1997).

This technique investigated the relationships between science achievement of agriscience program completers and teacher certification, with "1" meaning professional and "2" meaning provisional, by analyzing science scores and teacher certification types. The variables of gender, with gender coded as "1" meaning male and "2" meaning female, and socioeconomic status, coded as a percentage of students in the school being economically disadvantaged, were analyzed as other explanatory variables. The ANOVA performed pair-wise comparisons of the variables of gender and certification type along with their interactions. Pair-wise comparisons were necessary to discern interactions between and among variables in the study. Table 4 is a summary of the ANOVA and shows no statistically significant interaction of the independent variables (teacher certification type, gender and socioeconomic status) with the dependent variable of science achievement on the MEAP test, F (1, 4) = 5.902, p = .984. Based on the analysis, the null hypotheses were retained.

Table 4

MEAP Science Achievement Test Analysis of Variance Summary of Michigan Agriscience Program Completers with Science Score as the Dependent Variable

Source of Variation	*SS*	*d*f	*MS*	*F*	P value
Socioeconomic Status	9537.02	1	9537.02	3.84	.05
Gender	6515.82	1	6515.82	2.62	.11
Certification Type	14676.26	1	14676.26	1.32	.25
Error	1457066.01	591	2486.46		
Interaction	1487628.23	590		5.90	.98

Research Objective #5: Other Factors

Analysis of Variance for Ranks was used to analyze the categorical data of science proficiency level and its relationship with certification types and gender with socioeconomic status as a confounding variable to consider. This procedure was the most appropriate procedure to use because it compared categorical data while factoring socioeconomic status as quantitative data (Gravetter & Wallnau, 2000).

In this analysis, the independent variables of gender, teacher certification, and socioeconomic status are coded the same as the earlier ANOVA. The difference in this analysis is that science achievement is presented as categorical data identified as a placement level of 1, 2, 3 or 4. Table 5 provides a summary of this operation showing the totals of each type of category for the variables of proficiency level, gender and certification type. There are four levels of proficiency in science achievement ranging from "1" being highly proficient to a "4" being not proficient.

When interpreting data from this analysis, the explanatory variables represent the log odds for average change in placement category if found to be significant. The ANOVA for Ranks summary displays standard error of measurement (*SE*), degrees of freedom (*df*), log odds of category change (*B*), and P value. Table 5 is a summary of the ANOVA for Ranks and shows no statistically significant interaction of the independent variables with the average change in placement category of the dependent variable, F (1, 4) = 1.978, p = .05. The categorical variables of gender and certification type are noted at the bottom of the table. The gender of female is the reference category in the analysis. The reference category is the gender used to compare the log odds of higher placement into another category by males. The same is applicable to the reference category of provisional certification. Based on the analysis, the null hypothesis was retained.

Table 5

MEAP Science Achievement Test Analysis of Variance for Ranks Summary of Michigan Agriscience Program Completers

Source of Variation	*SS*	*df*	*MS*	*B*	*F*	P value
Socioeconomic Status	1.11	1	1.11	.004	1.49	.22
Gender[a]	1.05	1	1.05	.25	1.41	.24
Certification Type[b]	.001	1	.001	.17	.001	.98
Error	436.41	591	.75			
Interaction	5.89	590			1.98	

[a] The reference category is female

[b] The reference category is provisional certification

Conclusion

This chapter outlines the data collection techniques used to address the research objectives. Data sources were used to develop a comprehensive data set of Michigan high school agriscience program completers that included raw science score and proficiency level on the MEAP science test, student gender, teacher certification and socioeconomic data on the school. The statistical methods utilized included descriptive statistics, ANOVA and ANOVA for Ranks to complete the research objectives. Key findings included: a majority of the agriscience program completers had a teacher with professional certification, a majority of agriscience teachers possessed a science minor, no statistically significant difference was found between the general population and the agriscience program completer population, and the variables of gender, teacher certification and socioeconomic status were not found to have a statistically significant effect on the science achievement measured by raw score and placement level of agriscience program completers.

CHAPTER 5 CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

The purpose of this study was to investigate the relationships between agriscience education student achievement in science and agriscience teacher certification. To achieve this purpose, an instrument was developed to gather data on the population of agriscience program completers who had taken the MEAP science test of the Michigan Department of Education. The instrument included student demographic data from the Michigan Department of Labor and Economic Growth and also agriscience teacher certification data from the Michigan Department of Education. Socioeconomic data was collected from Standard and Poor's School Assessment database. Student demographic data included gender, home high school, MEAP science raw scores and categorical scores and socioeconomic data. Teacher data included certification type classified as provisional or professional.

In order to assist in meeting the research purpose, five research objectives were established:

1. Identify the Michigan population of agriscience teachers and classify their teaching certificate type and certification areas;
2. Identify completers of high school agriscience programs and determine their categorical score and raw score on the MEAP science test and compare the agriscience program completer population to the general population;

3. Investigate the socioeconomic status of the schools included in the study and include in analysis as a confounding variable;
4. Investigate the relationship between teacher certification and student achievement in science on the MEAP science test measured by raw scores and also analyze the variables of gender and socioeconomic status; and
5. Investigate the variables of teacher certification, gender and socioeconomic status on the MEAP science test measured by placement level.

The conclusions, implications and recommendations for this study are organized by research question. This study was limited to the agriscience program completer population during the time period when the research took place and by availability of socioeconomic data. As documented in the review of literature, this study added to the body of knowledge in the field of agriscience education and created new questions for future researchers to consider. This study was limited to the population under investigation and caution should be exercised in generalizing to any other populations.

Research Objective #1: Teacher Demographics

The first research objective identified the Michigan population of agriscience teachers and classified their teaching certificate type. The study found in the agriscience program completer population of Michigan public high school single-teacher agriscience programs (N=61), 60.4% of the students had teachers who held the professional certificate. Attaining the professional certificate requires completion of three years of teaching and completion of coursework or inservice training (Michigan Department of Education, 2008b). It was concluded that over half of the agriscience teachers remained in the profession for more than three years and attained advanced certification. The majority of agriscience teachers in Michigan was composed of teachers who endured the early career experiences associated with teaching agriscience (Walker, Garton, & Kitchel, 2004).

This implied that the majority of public high school agriscience teachers in Michigan are experienced and have met required standards in professional development. The majority of agriscience teachers in Michigan are likely to be more effective teachers with the knowledge and skills that develop with experience. Not only have they completed essential elements for advanced licensure, but they also possess the necessary attributes to attain tenure at their local school as well. This implied a mindset towards professional development and lifelong learning, even if only for the time needed to obtain the advanced certification.

As local, state and federal mandates shape the present and future educational system, agriscience teachers must be a part of the solution to educational change and programming. Student achievement, as measured by the Michigan Educational Assessment Program, directly impacts how schools and teachers are evaluated because Michigan school code evaluates schools based on a grading system that accounts for achievement scores as measured by state proficiency tests (Michigan Department of Education, 2008c). Agriscience programs, if they are to remain a viable component of the traditional high school concept, will be expected to contribute to student success in science achievement. Currently in Michigan, many students receive science credit for successful completion of agriscience courses. If this practice is to continue, agriscience teachers must be willing to remain current and flexible in adapting science-based mandates for curriculum and instruction.

A majority of agriscience teachers in Michigan have an endorsement in a science minor including biology, earth science and chemistry. This means the teachers have completed approximately 20 additional credit hours in science (Michigan State University, 2008b). If agriscience teachers are asked to integrate science beyond the scope of biology and life science into the agriscience curriculum, future research is needed to investigate the breadth and depth of scientific knowledge of agriscience teachers, in general, and specifically by science area. Integrating beyond the scope of biology and life science would also provide a need for Michigan State University, the only agriscience teacher preparation program in Michigan, to offer a science minor such as Integrated Science for agriscience undergraduates to pursue for certification. The Integrated Science minor includes a broader range of science disciplines including physics, earth science, biology and chemistry. This would broaden the science knowledge base of agriscience teachers, enhance their employability options and build credibility with traditional science teachers (J. Glazier, personal communication, September 10, 2008).

Research Objective #2: Student Demographics

The agriscience program completer population was exclusively comprised of completers of public high school agriscience programs in a traditional setting, and did not include program completers from career and technical centers, career academies, or other programs offered outside of the traditional high school concept. Descriptive statistics of the general population and the agriscience program completer population produced variation in maximum and minimum scores which resulted in the general population with a larger spread of scores (794) than the agriscience program completer population (302). It is concluded that the agriscience completer population had fewer extreme scores resulting in a smaller spread of scores. Both populations' scores appeared to be normally distributed when plotted on a histogram. Because the hypothesis used for this objective was non-directional, a two-tailed t-test was used. The results revealed no statistically significant difference between the agriscience completer population and general overall population mean scores on the MEAP science test.

The finding was consistent with earlier research in the area of student performance on science achievement in similar studies in the field of agriscience education. Connors and Elliott (1995) found no significant difference within sub-groups of a sample of Michigan high school senior students on a science achievement test. One difference between this study and the Connors and Elliott study is this study utilized census data and Michigan Department of Education data compared to a sample of four Michigan high schools and a general science knowledge test used in the Connors and Elliott study (1995). Another difference is that this study also compared differences based on teacher certification where Connors and Elliott did not.

The findings from this study did not support the Chiasson and Burnett (2001) study where Louisiana high school students enrolled in agriculture courses scored significantly higher on a state science assessment and that they were more likely to pass the science assessment. This study and the Chiasson and Burnett study are similar in datasets as both employ census data studies, but the two differ in that this study investigated a unique subpopulation of agriscience students in Michigan compared to a census of all agriscience students in Louisiana. This study defined the sample population as completers of Michigan high schools that offered agriscience programs. The Chiasson and Burnett study included all 11th grade agriscience students' test scores on the Louisiana state science proficiency test.

The findings revealed no statistically significant difference in the mean scores of the agriscience completer population and the general overall populations. This finding was supportive of the statement that all agriscience program completers achieve equal scores to the state general student population. Science test scores are used to categorize students into four levels. Level 1 is the highest proficiency and Level 4 is the lowest proficiency. Levels 1 and 2 meet state science standards, whereas, Levels 3 and 4 do not meet state science proficiency standards.

The agriscience completer population had a lower percentage of students in Level 1 and 4 and a higher percentage of students in Levels 2 and 3 when compared to the general population. Based on this observation, agriscience programs do not have as many high achieving students, such as Level 1 type. Shelley-Tolbert, Conroy and Dailey (2000) revealed that agriscience teachers anticipated more high achieving students as a result of science integration.

High school students who achieve a Level 1 or 2 rating in all core areas of the Michigan Educational Assessment Program earn a $2500 scholarship (State of Michigan, 2008). In addition, the aggregate test data for each school is used to evaluate schools as a part of No Child Left Behind (Michigan Department of Education, 2008c). These two factors create a situation where state assessment is "high stakes" for both students and schools. Students are working to earn scholarship money and schools are being evaluated based on the same assessment. This implied that local agriscience programs must be a contributing part of the educational system. As students and entire schools receive increasing publicity for their ability in local, state and federal assessments, parents and administrators will be looking for programs that can positively influence student success in these assessment tools.

As state curricula change, so do measurement and assessment practices of students and schools. Michigan assessments are changing to include the Michigan Core Curriculum tests of mathematics, language arts, science and social studies along with an assessment by the American College Testing (ACT) Program (Michigan Department of Education, 2008g). The ACT assessment is an additional indicator of student performance and is correlated to future success in post-secondary education (ACT, Inc., 2008). Additional assessment components add another dimension to better understanding the impact of the educational process. The science component of the ACT assessment includes science interpretation that is linked to reading and reasoning proficiency. It is recommended that agriscience programs include additional emphasis on reading to help students excel on the science component of the ACT assessment.

The findings of research objective two provided baseline data for further research. Additional research should compare achievement of agriscience students to students in other career and technical programs. This study was limited to Michigan high school agriscience program completers. Future research should include science test item analysis to better understand which domains of science are taught and assessed through the Michigan Agriscience and Natural Resources Curriculum. Biology is the primary domain integrated in the curriculum. Chemistry and earth science are also integrated in the curriculum, but to a lesser extent.

Michigan high school graduation requirements include life science, physics or chemistry, and one additional science class (Michigan Department of Education, 2008h). Examples of the additional science classes include advanced levels of biology, chemistry or physics, advanced placement courses, specialized courses such as microbiology, ecology or genetics, or agriscience courses with a science emphasis. The Michigan Department of Education should grant life science credit to students for successful completion of an agriscience program with an emphasis in courses such as animal science, plant science and natural resources assuming life science standards are met. Agriscience programs should review their content area and align their courses to meet science credit requirements of their school. Contingent upon the Michigan Department of Education granting life science credit to agriscience program completion, community colleges and universities should accept agriscience coursework as entrance credit in the area of life science. It is also recommended that all agriscience programs in Michigan develop articulation agreements with community colleges and universities for courses that align with technical training programs in agriculture. An example of this is an agreement where a high school student completes a secondary agriscience course in horticulture and the community college or university accepts completion of the secondary agriscience course as completion of its equivalent at the post-secondary level.

The analysis of the agriscience program completer population and the general population showed no statistical difference in mean score on the Michigan Educational Assessment Program Science test. Based upon this finding, it is concluded that agriscience students have an equivalent science experience through assessment from their agriscience courses. High schools should look to the agriscience program as an option for students who have interest in the field of agriculture for contextual learning in science. Future research should focus on the efficacy of student preferences in regards to science curriculum choices in agriscience and student achievement in science.

The finding that there was no significant difference in science achievement between the general population and the agriscience program completer population implies that high school agriscience programs serve students equally. Because of distance from the MSU campus, it is recommended that the Michigan Department of Education identify other Michigan teacher preparation institutions that could provide inservice and further professional development in science education. Additional institutions located throughout the state could offer agriscience and science teachers opportunities to expand their scientific knowledge and further integrate agriscience programs into science education. Agriscience education offers the opportunity for students to experience science in an applied context.

Agriscience teachers deliver programs to these students and contribute to the total educational system. A potential partner includes Ferris State University located in Big Rapids, Michigan, which offers technical training in ornamental horticulture, surveying technology, pre-veterinary medicine and environmental biology (Ferris State University, 2008). Another potential partner is Lake Superior State University in Sault Saint Marie, where programs in fisheries and wildlife management, environmental chemistry, and parks and recreation management complement the Michigan Agriscience and Natural Resources Curriculum (Lake Superior State University, 2008). It is also recommended that teacher preparation institutions update existing Michigan Department of Education teacher education standards into pre-service training methods and that agriscience teacher testing standards be consistent with teacher education standards.

Ricketts, Duncan and Peake (2006) investigated science achievement in Georgia as affected by degree of involvement in the agriscience program. This study considered science achievement as one score. Additional investigation including mapping test items to science domains on the MEAP science test would help better understand if there are certain domains of science where agriscience students have more, or less, of an advantage. Additional research on subject matter content including mathematics and language arts would also contribute to the understanding of the impact of agriscience education efforts in the state.

Research Objective #3: Socioeconomic Status

The third research objective identified socioeconomic status of students with the percentage of economically disadvantaged students in the school and compared the data to science test scores. Findings for this objective found no statistically significant effect of socioeconomic status on the dependent variable of science achievement on the Michigan Educational Assessment Program within the agriscience program completer population. The study identified socioeconomic status through the percentage of economically disadvantaged students in the school of each student. This was determined by referencing the Michigan school district and school building database.

It is concluded that since the agriscience program completer population was drawn from the Michigan public high schools offering agriscience programs, the socioeconomic status of agriscience program completers was no different than the socioeconomic status of the schools of the agriscience program completer population. The socioeconomic data was limited to the Michigan public high schools offering agriscience programs. A limitation to the data collection procedure limits conclusions to this research objective.

Agriscience programs serve students of many different backgrounds in multiple communities throughout the state of Michigan. The findings of Research Objective #3 imply that socioeconomic status of the agriscience program completer population and the schools they attended are equal and similar results may be found from further research within schools. Further socioeconomic status research on populations of rural versus urban settings may find variation on the effect of socioeconomic status as this sample population included only completers of public high school agriscience programs.

Future research should investigate a wider range of Michigan agriscience students beyond the agriscience program completer population in this study. Future research should specifically compare agriscience students from all socioeconomic strata to determine the existence of any differences in performances on standardized tests. Access to individual student socioeconomic status data was not available to the researcher. Access to this data would allow more specific analysis of socioeconomic status and would identify the variable by individual student versus by school as in this study.

Research Objective #4: Student Achievement and Teacher Certification

The fourth research objective investigated the relationship between agriscience teacher certification and agriscience student achievement on the MEAP science test for the school years of 2003-04 and 2004-05 by completers of Michigan high school agriscience programs. No statistically significant difference was found between the means of the sub-groups, delineated by gender and teacher certification type, of the agriscience completer population in this study with gender and certification types as explanatory variables and socioeconomic status as a confounding variable.

It is concluded that provisional certification and professional certification are equally effective in impacting agriscience program completer achievement in science. This finding, in regard to teacher certification, contradicts the findings of previous research studies on teacher certification that found advanced teacher certification improved student achievement (Wayne & Youngs, 2003). Because research investigating agriscience teacher certification and its effect on science achievement is limited, this finding is new in the field of agricultural education and warrants additional investigation. Professional development may influence teacher knowledge for those teachers certified at both levels.

Based on the findings, it is concluded that teacher certification types are equally effective on the achievement of male and female students. In regard to gender differences, the findings oppose research by Johnson, Wardlow, and Franklin (1998) who reported females had higher achievement than males. It is not supportive of research identifying differences in scores between males and females on science achievement test (Burkham, Lee, & Smerdon, 1997).

The implications from Research Objective #4 impact teacher preparation and professional development. The agriscience teacher population included those certified through traditional certification procedures in the state of Michigan. A majority of

Michigan agriscience teachers have a science minor, usually in biology, based on the data the researcher found in the study (see page 50). Michigan State University certifies agriscience teachers and also certifies them in a minor area, usually biology. Courses completed within this minor at Michigan State University include an overview on the field of biology, microbiology, genetics, physiology and chemistry (Michigan State University, 2008b). Inclusion of the science minor in the Michigan State University teacher preparation program has been in place since the mid-1990s (R.J. Showerman, personal communication, March 5, 2008).

Provisionally-certified agriscience teachers are the newest graduates of the teacher preparation program and have had recent science classes in their pre-service training. Their knowledge base is adequate, based upon the results, to teach science content in the high school agriscience curriculum. Professionally-certified agriscience teachers have continual professional development and more experience that enhances their knowledge and technique in the classroom, but additional science course work is not mandatory within the construct of current teacher licensure practices in Michigan for professionally-certified teachers to renew their teaching license. It is implied that amount of science knowledge of teachers may be limited by current teacher licensure practices.

According to the American Association for Agricultural Education (Kantrovich, 2007), during the period of 2004 to 2006, there were 127 agriscience teachers in the state of Michigan with 95 of those teachers in programs with an emphasis in agriscience. The literature revealed that many agriscience teachers realize the benefit of science integration into the curriculum (Balschweid & Thompson, 2002; Boone et al., 2006; Conroy & Walker, 2000; Dyer & Osborne, 1999; Johnson, 1996; Myers & Washburn, 2008; Thompson & Balschweid, 1999, 2000; Thompson & Schumacher, 1998; Warnick & Thompson, 2007; Warnick, Thompson, & Gummer, 2004; Wilson et al., 2002). While attitudes and perceptions are a necessary precursor to integration, knowledge of subject matter and research of best teaching practices is imperative to move forward in the area of student achievement (Darling-Hammond & Youngs, 2002; Edwards, 2004; Lumpe, 2007; Raudenbusch, 2008).

Pre-service training and professional development practices by teacher educators should include science education as an integral component as the trend continues for higher expectations in student achievement, teacher licensure and integration of academic standards in career and technical education (Garet et al., 2001; Myers, Washburn, & Dyer, 2004; Windschitl & Thompson, 2006). Additional research in the field of agriscience education investigating student achievement should expand beyond the scope of science. This research should also consider the effect of reading skills and readiness (O'Reilly & McNamera, 2007) and could utilize the model proposed by Park and Osborne (2007) which incorporates agriscience students in utilizing contextual reading and vocabulary as a method to improve reading skills. Research should also consider mathematics achievement by students of agriculture. As federal and state mandates form and shape the nature of agriscience programs, research should be responsive to future changes.

This study did not include under-qualified teachers because the population encompassed too few students and teachers (n=3 and n=1, respectively) creating a unique, identifiable sub-group. Additional research in other states would add to the knowledge base built upon studies of Wayne and Youngs (2003) and Laczko-Kerr and

Berliner (2002). The effect of under-qualified agriscience teachers may have a greater impact in other areas of the nation where a higher number of teachers are defined as under-qualified exists.

Research Objective #5: Other Factors

The fifth research objective examined the variables that influenced agriscience program completer population science placement levels. The ANOVA for Ranks method allowed for analysis of categorical variables with a p-value set at 0.05 *a priori* in the study. This procedure allowed for further analysis based on the log odds of a student's MEAP science test level increasing to a higher categorical rating. The procedure analyzed the effects of teacher certification and gender on the log odds of a student being placed into a higher placement on the MEAP science test with socioeconomic status as a confounding variable.

No statistically significant difference was found among the variables of gender, socioeconomic status and certification. The finding is consistent with those of the fourth research objective. It is concluded that Michigan public high school agriscience programs serve both genders equally based on science achievement from the nearly equal distribution of males (n=296) and females (n= 297) identified as program completers.

Agriscience programs provide science education in an agricultural learning context. It is implied from the results of this study that agriscience programs could be marketed as effective science education programs for students in the area of science. The findings are limited to Michigan public high school agriscience programs. Future research in the population of students at career and technical centers may find different results.

Future research should investigate gender differences in student achievement across a broader scope of Michigan agriscience students based on teacher certification. This could provide further insight to influence teacher training and improve instructional strategies and learning experiences. Future research should assess gender enrollment in different Michigan agriscience courses to identify areas of interest by gender. Changes and additions to the curriculum at the state level should be evaluated to reflect student interest while maintaining academic rigor.

Michigan agriscience teachers have multiple strategies to teach students the theory and practice of agriscience. These strategies are implemented in the components of agriscience education that include instruction, supervised experiential learning and leadership development through participation in the National FFA Organization (Hoover et al., 2007). Additional studies should examine the time restraints that agriscience teachers face in utilizing these strategies (Stewart et al., 2004; Myers et al., 2005). Benefits could be derived from research on agriscience teachers and their time spent in science instruction across various teaching strategies within the components of agriscience education.

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LIST OF REFERENCES

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APPENDICES

Appendix A: Data Collection Instrument

This appendix is included to show the instrument used in the study and the sources of data used to implement the use of the instrument. The table below is taken from the instrument with definitions of each data category and source of information.

District Code	Building Code	UIC	Science Score	Science Placement	Certification Type	SES	Gender	Certification

District code: code assigned by Michigan Department of Education

Building code: code assigned by Michigan Department of Education

UIC (Unique Identifying Code): assigned by Michigan Department of Education

Science Score: recorded as a numerical score from the MEAP science test

Science Placement: recorded as Level 1, 2, 3 or 4 on the MEAP science test

Certification Type: teacher certification recorded as 1 (professional) or 2 (provisional)

SES (Socioeconomic Status): coded as a percentage of economically disadvantaged with each subject's school

Gender: coded as 1 (male) or 2 (female)

Appendix B: Purdue Institutional Review Board Approval

PURDUE
UNIVERSITY

HUMAN RESEARCH PARTICIPANTS PROTECTION PROGRAM
INSTITUTIONAL REVIEW BOARDS

To:	MARK BALSCHWEID AGAD
From:	RICHARD MATTES, Chair Social Science IRB
Date:	06/19/2006
Committee Action:	**Expedited Approval**
Approval Date:	06/15/2006
IRB Protocol #:	0606004060
Study Title:	A Comparison of Michigan High School Student Performance in Statewide Science Assessment Based on Participation in Agricultural Science Coursework--June 2006
Expiration Date:	06/14/2007

The above-referenced protocol was granted approval following review by the Institutional Review Board (IRB). If written informed consent was submitted as part of your protocol, the IRB-stamped and dated "master" consent form(s), approved by the IRB for this protocol only, are attached. Please make copies from the attached "master" document(s) for subjects to sign upon agreeing to participate. The original consent forms signed by subjects should be placed in your study files and maintained for a period no less than three (3) years following the termination of the protocol. A copy of the signed consent form should be given to the subject.

Continuing Review: It is the Principal Investigator's responsibility to obtain continuing review and approval for this protocol prior to the expiration date noted above. Please allow sufficient time for continued review and approval. No research activity of any sort may continue beyond the expiration date. Failure to receive approval for continuation before the expiration date will result in the approval's expiration on the expiration date. Data collected following the expiration date is unapproved research and cannot be reported or published as research data. If you do not wish to continue approval, please notify the IRB of the study closure.

Adverse Events: All adverse events that occur at a Purdue University research site must be reported to the IRB within three (3) business days of recognition/notification of the event. If the adverse event occurred at an external site as part of a multi-site research project for which Purdue University is the lead institution, it must be reported to the IRB within ten (10) business days.

Amendments: If you wish to change any aspect of this study, please submit the requested changes to the IRB. No new procedure may be implemented until IRB approval has been granted.

If you have any questions or concerns, please contact our office.

PI: Mark A. Balschweid Ref # 0606004060

Title: A Comparison of Michigan High School Student Performance in Statewide Science Assessment Based on Participation in Agricultural Science Coursework

WAIVER OF INFORMED CONSENT
45 CFR 46.116(d)

Having conducted expedited review of the above protocol, the IRB hereby finds and documents the following:

(1) The research involves no more than minimal risk to the subjects;

(2) The waiver will not adversely affect the rights and welfare of the subjects;

(3) The research could not practicably be carried out without the waiver; and

(4) Whenever appropriate the subjects will be provided with additional pertinent information after participation.

Date: 6/15/06

Signature: ______________________________

Richard D. Mattes, Ph.D., IRB Chair
Regina A. Kreisle, M.D., IRB Associate Chair
Jeannie D. DiClementi, Psy.D., IRB Associate Chair

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HUMAN RESEARCH PARTICIPANTS PROTECTION PROGRAM
INSTITUTIONAL REVIEW BOARDS

To:	MARK BALSCHWEID AGAD
From:	RICHARD MATTES, Chair Social Science IRB
Date:	05/31/2007
Committee Action:	**Renewal**
Approval Date:	~~06/15/2006~~ 5/29/07
IRB Protocol #:	0606004060
Study Title:	A Comparison of Michigan High School Student Performance in Statewide Science Assessment Based on Participation in Agricultural Science Coursework--June 2006
Expiration Date:	05/28/2008

The above-referenced protocol was granted approval following review by the Institutional Review Board (IRB). If written informed consent was submitted as part of your protocol, the IRB-stamped and dated "master" consent form(s), approved by the IRB for this protocol only, are attached. Please make copies from the attached "master" document(s) for subjects to sign upon agreeing to participate. The original consent forms signed by subjects should be placed in your study files and maintained for a period no less than three (3) years following the termination of the protocol. A copy of the signed consent form should be given to the subject.

Continuing Review: It is the Principal Investigator's responsibility to obtain continuing review and approval for this protocol prior to the expiration date noted above. Please allow sufficient time for continued review and approval. No research activity of any sort may continue beyond the expiration date. Failure to receive approval for continuation before the expiration date will result in the approval's expiration on the expiration date. Data collected following the expiration date is unapproved research and cannot be reported or published as research data. If you do not wish to continue approval, please notify the IRB of the study closure.

Adverse Events: All adverse events that occur at a Purdue University research site must be reported to the IRB within three (3) business days of recognition/notification of the event. If the adverse event occurred at an external site as part of a multi-site research project for which Purdue University is the lead institution, it must be reported to the IRB within ten (10) business days.

Amendments: If you wish to change any aspect of this study, please submit the requested changes to the IRB. No new procedure may be implemented until IRB approval has been granted.

If you have any questions or concerns, please contact our office.

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UNIVERSITY

HUMAN RESEARCH PROTECTION PROGRAM
INSTITUTIONAL REVIEW BOARDS

To:	MARK BALSCHWEID AGAD 224
From:	RICHARD MATTES, Chair Social Science IRB
Date:	05/29/2008
Committee Action:	**Renewal**
Approval Date:	~~06/15/2006~~ 5/27/08
IRB Protocol #:	0606004060
Study Title:	A Comparison of Michigan High School Student Performance in Statewide Science Assessment Based on Participation in Agricultural Science Coursework--June 2006
Expiration Date:	05/26/2009

The above-referenced protocol was granted approval following review by the Institutional Review Board (IRB). If written informed consent was submitted as part of your protocol, the IRB-stamped and dated "master" consent form(s), approved by the IRB for this protocol only, are attached. Please make copies from the attached "master" document(s) for subjects to sign upon agreeing to participate. The original consent forms signed by subjects should be placed in your study files and maintained for a period no less than three (3) years following the termination of the protocol. A copy of the signed consent form should be given to the subject.

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If you have any questions or concerns, please contact our office.

Appendix C: Michigan Department of Education OEAA Approval

STATE OF MICHIGAN
DEPARTMENT OF EDUCATION
LANSING

JENNIFER M. GRANHOLM
GOVERNOR

MICHIGAN Department of Education

MICHAEL P. FLANAGAN
SUPERINTENDENT OF
PUBLIC INSTRUCTION

August 14, 2006

Mr. John Schut
8106 Ingalls Road
Belding, MI 48809

Dear Mr. Schut,

Please find enclosed a CD with all the data you need to complete your research project. If you have any questions about the data, please contact me.

We are happy to be able to facilitate your research, and appreciate your assurance that you will abide by all Michigan Department of Education requirements for storing, analyzing, and publicizing results based on these data.

Sincerely,

Joseph

Joseph A. Martineau, Ph.D.
Psychometrician, MDE/OEAA
608 W. Allegan
Lansing, MI 48909

608 WEST ALLEGAN STREET • P.O. BOX 30008 • LANSING, MICHIGAN 48909
www.michigan.gov/mde • (517) 373-3324

Appendix D: Michigan Department of Labor and Economic Growth OCTP Agreement

JENNIFER M. GRANHOLM
GOVERNOR

STATE OF MICHIGAN
DEPARTMENT OF LABOR & ECONOMIC GROWTH
OFFICE OF CAREER AND TECHNICAL PREPARATION
PATTY CANTÚ, DIRECTOR

DAVID C. HOLLISTER
DIRECTOR

CAREER AND TECHNICAL EDUCATION DATA SECURITY AGREEMENT

I, John H. Schut, of Purdue University,

dated September 11, 2006, AGREE TO:

- To treat all Career and Technical Education data in accordance with the Michigan Freedom of Information Act (FOIA), the Privacy Act, the Family Educational Rights and Privacy Act (FERPA), and the CTEIS Data Access and Management Policy. Of particular importance in handling the data is the understanding of statistical cutoffs and restricted access as defined in these policies. Every effort will be made to protect the identity of individual students.

- To observe the appropriate levels of disclosure when entering, transferring, storing, manipulating, transforming, analyzing, viewing, or otherwise working with the Career and Technical Education data, and to use considerable care when engaging in the following types of activities that could lead to the disclosure of personally identifiable information:
  - Discussing, publishing, or otherwise disseminating information gathered or reviewed;
  - Transferring data or allowing data to be transferred to third parties;
  - Unsecured disposal of printed information (which must be avoided).

- Acknowledge and assure that the conditions set forth in this security agreement when working with any data provided by the Office of Career and Technical Preparation will be adhered to and that the Michigan Department of Labor & Economic Growth, Office of Career and Technical Preparation (DLEG/OCTP), will be notified if and when a breach in security is evident by me or a third-party representative.

- Authorize the following staff members and agents of this office, including contracted researchers, to utilize the data in the course of their respective duties and ensure that they have read and agreed to the conditions of this data disclosure:

NAME Last Name, Full First Name	**LEVEL REQUEST**	**EMAIL ADDRESS**	**Signature** DLEG/OCTP receives original signatures – no photocopies
Schut, John	3	jhschut@aol.com	John H. Schut

NOTE: After reading this security agreement and signing the above lines, individual staff and third-party representatives agree to observe this level of data security when utilizing OCTP data sets and further agree to appropriately utilize the data in the strictest of confidence. Sharing of any private data with unauthorized parties constitutes an illegal act and is subject to penalties imposed under FERPA.

Authorized Signature: John H. Schut Date: 9-11-2006

Title: Research – Graduate Student

DATA ACCESS REQUEST APPROVED BY:

Authorized Signature: ______________________ Date: __________

Title: ______________________

VITA

VITA

John Schut is a doctoral student at Purdue University pursuing a degree in Agricultural Education. He began his doctoral studies while continuing to serve as an agriscience teacher at Lowell High School (MI). At Lowell, he taught courses in animal science, plant science, natural resources, leadership, landscape horticulture and equine science. Schut was named the National Association of Agricultural Educators Region IV Outstanding Young Member in 2001. The following year, the Lowell program was awarded the National Association of Agricultural Educators Region IV Outstanding Program and Schut was named the Association for Career and Technical Education Outstanding New Teacher for Region I. Schut served as president of the Michigan Association of Agriscience Educators in 2003 and the National Association of Agricultural Educators Professional Growth Committee Chair in 2005.

Since 2004, Schut has served Caledonia High School (MI) as its agriscience teacher where he has taught leadership, horticulture, equine science, food science and integrated freshman science. Caledonia's program was named the 2007 National Association of Agricultural Educators Region IV Outstanding Program and he was named the 2008 Michigan Association of Agriscience Educators Outstanding Teacher. He also teaches Horticulture 143 at Ferris State University in Big Rapids, Michigan.