5-1-2017

COMPARATIVE ASSESSMENT OF AGRICULTURAL LITERACY IN SELECTED K-5 CLASSROOMS EMPLOYING AGRICULTURE IN THE CLASSROOM METHODOLOGIES: A SOLOMON FOUR-GROUP ANALYSIS

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COMPARATIVE ASSESSMENT OF AGRICULTURAL LITERACY IN SELECTED K-5 CLASSROOMS EMPLOYING AGRICULTURE IN THE CLASSROOM METHODOLOGIES: A SOLOMON FOUR-GROUP ANALYSIS

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B.S., Southern Illinois University, 2007
M.S., Southern Illinois University, 2012

A Dissertation
Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

Doctoral Program in Agricultural Sciences
In the Graduate School
Southern Illinois University Carbondale
May 2017
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Mary Margaret Fischer

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of
Doctor of Philosophy
in the field of
Agricultural Sciences

Approved by:

Dr. Seburn L. Pense, Chair
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Graduate School
Southern Illinois University Carbondale
February 28, 2017
AN ABSTRACT OF THE DISSERTATION OF

Mary Margaret Fischer, for the Doctor of Philosophy degree in Agricultural Sciences, presented on February 28, 2017 at Southern Illinois University Carbondale.

TITLE: COMPARATIVE ASSESSMENT OF AGRICULTURAL LITERACY IN SELECTED K-5 CLASSROOMS EMPLOYING AGRICULTURE IN THE CLASSROOM METHODOLOGIES: A SOLOMON FOUR-GROUP ANALYSIS

MAJOR PROFESSOR: Dr. Seburn L. Pense

The significance of agriculture to future generations is unparalleled. The United Nations projects the global population to swell to 9.75 billion people by 2050, and to proliferate to 11.2 billion by 2100. The non-agricultural population has little to no understanding or comprehension of the complexities of sustaining a viable agricultural system. Agricultural literacy is an area often unseen and rarely discussed outside specific agricultural disciplines. Society does not view agriculture as being important, yet it is important that society be properly educated on issues in order to reach well-informed decisions and render prudent choices that impact the world around them. Illinois ranks fourth in the nation for agricultural productivity, yet the agricultural literacy of its elementary students is unknown.

The purpose of this study was to assess the agricultural knowledge of selected Illinois classrooms of public elementary school students in kindergarten through fifth grades that employ Agriculture in the Classroom (AITC) methods and materials. A quasi-experimental nonequivalent control group design, using a pretest and a posttest, was utilized to study. A Solomon Four-Group design analysis was used to determine if pretest sensitization, or test reactivity effect, existed in this study.

The study found that AITC treatment and control group students possessed some agricultural knowledge regarding the five thematic areas of the Food and Fiber Systems Literacy (FFSL) Framework. The kindergarten through first grade post mean scores by treatment and
theme indicated the treatment group answered 77.89 percent of the questions correctly and the control group answered 72.55 percent correctly. The treatment and control groups were most knowledgeable about Theme 5 (Food, Nutrition and Health) followed by Theme 4 (Business and Economics), with the treatment group being more knowledgeable about Theme 1 (Understanding Food and Fiber Systems), while the control group was more knowledgeable about Theme 3 (Science, Technology and Environment). The treatment and control groups were least knowledgeable about Theme 2 (History, Geography and Culture).

The second through third grade post mean scores by treatment and theme indicated the treatment group answered 75.05 percent of the questions correctly and the control group answered 74.07 percent correctly. The treatment group was most knowledgeable about Theme 3 (Science, Technology and Environment) followed by Theme 1 (Understanding Food and Fiber Systems) and Theme 5 (Food, Nutrition and Health). The control group was most knowledgeable about Theme 1 (Understanding Food and Fiber Systems) followed by Theme 3 (Science, Technology and Environment) and Theme 4 (Business and Economics). The treatment and control groups were least knowledgeable about Theme 2 (History, Geography and Culture).

The fourth through fifth grade post mean scores by treatment and theme indicated the treatment group answered 66.73 percent of the questions correctly and the control group answered 52.91 percent correctly. The treatment group was most knowledgeable about Theme 2 (History, Geography and Culture) followed by Theme 3 (Science, Technology and Environment) and Theme 5 (Food, Nutrition and Health). The control groups were most knowledgeable about Theme 3 (Science, Technology and Environment) followed by Theme 1 (Understanding Food and Fiber Systems) and Theme 4 (Business and Economics). The treatment was least knowledgeable about Theme 4 (Business and Economics) and Theme 5 (Food, Nutrition and
Health). The control group was least knowledgeable about Theme 2 (History, Geography and Culture) followed by Theme 5 (Food, Nutrition and Health).
DEDICATION

Posthumously, to my parents, Christian and Henrietta Catherine Conkerton Fischer and to my oldest brother, Christian Fischer, IV: To my parents, your sacrifices for my brothers and I have inspired me to strive to become the best person that I could be—generous, supportive, and giving, all without expectation of recompense or earthly reward. I learned so much from both of you through your dedication to our family and to others. You were the best of parents always giving unconditional love, faith, and support. And to my brother, Chris, I miss you very much. Thank you for spending that hot summer on the university farm welding the cattle gap to purchase a bareback pad for one-eyed Nell.

To my “sole survivor” brother, Douglas Henry Fischer, Sr.: Thank you for all your encouragement and brotherly threats of violence to “get ‘er done”.

To my “best and worst critic”, Matthew Calvert MacCrimmon: Your encouragement, “tough love”, and belief in me to return to college at 50 and earn my BS and subsequent degrees is greatly appreciated. You are the love of my life.

To the Lord of my faith, I humbly thank You for all things, good or seemingly bad, for You do not give us more than we are able to bear, but help us to overcome adversity and be better for it.

“If we knew what it was we were doing, it would not be called research, would it?”

Albert Einstein
ACKNOWLEDGMENTS

I would like to express my gratitude to my advisor, Dr. Seburn L. Pense, for his guidance, support and patience throughout the creation of this dissertation. I wish to thank my other committee members: Dr. Karen L. Jones for your encouragement, Dr. Logan Park for your cheerful support; and Dr. Terry Clark for your support throughout my academic career-Go Aggies! An undertaking like this does not happen without individuals such as yourselves to “make it so”.

I am sincerely grateful to Laurie George for her support, patience, and guidance while grading the pretests and posttests for this study; and Dr. Brian Klubek and Dr. Karen L. Jones for supporting me through my doctoral program. I whole-heartedly appreciate the office staff in the Plant, Soil and Agricultural Systems Department, Mary Dunmyer and Patti Deskines, for their support, assistance and encouragement throughout my doctoral studies and tolerating the never-ending questions and complaints from students.

I sincerely appreciate the assistance and dedication of my fellow Ag Literacy Coordinators, who helped make this study possible, namely, Maria Farris, Williamson County; Melissa Lameczyk, Franklin County; Martha Cripe, Fayette County, Rhodora Collins, DeKalb County; Dawn Weinberg, Carthage County; Terra Bertolini, McLean County and Union County Farm Bureau Manager, Stephanie Rhodes.

I wish to thank all the school principles, teachers, and students whose participation made this study possible.

Finally, I wish thank my sons, Dave, Reuben, John, and Christopher, for their support and encouragement, which has been invaluable. I dearly love you all.
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CHAPTER 1

INTRODUCTION

The significance of agriculture to future generations is unparalleled. The United Nations projects the global population to swell to 9.75 billion people by 2050, and to proliferate to 11.2 billion by 2100 (United Nations, 2015). This increase in population will demand greater food production in the next 50 years than the previous 10,000 years combined (Borlaug, 2000). Agricultural production practices, such as concentrated animal feeding operations (CAFO), pesticide and fertilizer usage, and environmental issues, such as water usage, erosion, and non-point source pollution are increasingly coming under strong review and criticism (Horrigan, Lawrence, & Walker, 2002). Other issues including antibiotic use in animals, animal safety, as well as the heated debates over genetically modified organisms (GMOs) have been misrepresented in the media and supported by special interest groups (Leising, Heald, Hubert, & Yamamoto, 1998). The non-agricultural population has little to no understanding or comprehension of the complexities of sustaining a viable agricultural system (Doerfert, 2011, p. 8). Doerfert (2011) found that agricultural literacy is an area often unseen and rarely discussed outside specific agricultural disciplines. Society does not view agriculture as being important, yet it is important that society be properly educated on issues in order to reach well-informed decisions and render prudent choices that impact the world around them (Kovar & Ball, 2013, p. 168).

The population of the United States, once a predominately agrarian society, has been transformed into an urban society. This is supported by the fact that only 1 percent of our population provided food, fuel, and fiber for Americans and peoples around the world in 2012, down 3.1 percent from 2007 (United States Department of Agriculture, 2015). The
United States Environmental Protection Agency (EPA) concurred in their report that less than 2% of the U.S. population lived on farms and less than 1% claim farming as an occupation (United States Environmental Protection Agency, 2015). This trend toward urbanization has contributed to the decline of an agriculturally literate population (Kovar & Ball, 2013; Ryan & Lockaby, 1996; Pope, 1990). While advancements in technology and its adoption into agricultural production systems has increased efficiency, the distance between the farming and consumer populations have broadened (Birkenholz, Harris, & Pry, 1994, p. 1). The United States Department of Agriculture (USDA) reports that one farmer in the United States can feed 155 people. The American farmer today can realize a 262% increased yield in food production requiring 2% fewer farmer inputs (labor, seed, fertilizer, etc.) compared to farmers in 1950 (American Farm Bureau Federation, 2015).

These statistics, while impressive in the production capabilities of a single American farmer, who are few in number and aging, suggest a bleak future for agriculture. According to the 2012 Census of Agriculture, the last year for which data is available, the USDA figures indicated the average age of the American farmer is 58.3 years (United States Department of Agriculture, 2015). This figure up 1.2 years since 2007 and up 3 years since 2002 (National Sustainable Agriculture Coalition, 2014). This trend should be disturbing. Added to this, the number of total farmers is decreasing at a rapid rate according to the 2012 Census of Agriculture, indicating fewer people are choosing agriculture as a career option. Considering that the human population increases exponentially and food production increases linearly, there is an urgent need for an agriculturally and scientifically literate populace (Pimentel & Pimentel, 2008).
As the population of agriculturally literate individuals declines, society’s perception of agriculture changes. The term “agriculture” has long been associated with farming or ranching (Terry, Herring, & Larke, 1992). Kovar & Ball (2013) noted that masses of agriculturally literate individuals are needed to address the onslaughts of emotional negativity channelled through various media outlets. The public often understands and assimilates information, on which it bases its decisions and choices, through the professionals who are training the next generation of leaders and policy-makers, namely, educators (Elliot, 1999).

One strategy for addressing the concern with “agricultural literacy” occurred in 1988. The National Research Council’s Committee on Agricultural Education in Secondary Schools suggested “beginning in kindergarten and continuing through twelfth grade, all students should receive some systematic instruction about agriculture” (National Research Council, 1988, p. 2).

However, the definition of literacy is only the foundation that needs to be established. (Geier, Bonnet, & Bleam, 2013). Increases in the current knowledge and technology base have created a significant shift in what educators view as a “literate” student. There are many more forms of literacy than what was traditionally associated with the term including digital literacy, computer literacy, media literacy, information literacy, technology literacy, political literacy, cultural literacy, multicultural literacy and visual literacy according to the National Writing Project’s website, Digital Is (National Writing Project, 2014). Project 2061, a long-term research and development initiative of the American Association for the Advancement of Science (AAAS), through its Benchmarks for Science Literacy, has focused on science education for American students to become literate
in science, technology, engineering, and mathematics (STEM) courses beginning by the end of grades 2, 5, 8, and 12 (American Association for the Advancement of Science, 2015).

To be agriculturally literate, the National Research Council (NRC) originally envisioned that an agriculturally literate person “understand the food and fiber system, its history and its current economic, social and environmental significance to all Americans” (National Research Council, 1988, p. 8-9). Further, the NRC suggested the definition to encompass “some knowledge of food and fiber production, processing, and domestic and international marketing” (NRC, 1988, p. 9).

The Food and Fiber Systems Literacy Framework (FFSL) was a comprehensive curriculum developed by Leising (1998), to address the NRC’s concern for students from Kindergarten to 12th grade to become agriculturally literate citizens. As Leising pointed out, nearly ninety percent of the population was two or three generations removed from direct contact with agriculture. Youth know little about agricultural production, processing, marketing, distribution, regulation or research (Leising, Heald, Hubert, & Yamamoto, 1998). Today, youth are farther removed from agriculture and are more ambivalent regarding their food chain connections.

The FFSL was intended as a road map for infusing Food and Fiber Systems knowledge into core academic subjects and across grade levels (Leising, et al.1998). Sample instructional materials help teachers understand the Food and Fiber Systems standards and benchmarks by discovering how existing instruction connects to agriculture. Drake (1990) noted that the success of any program about agriculture intended for children depended on the ability of the teacher.
Leising stated the FFSL summarizes what America’s youth should know about the Food and Fiber Systems to be agriculturally literate by the time they graduate from high school.

In 2001-2002, the United States Department of Agriculture (USDA) contracted with the Department of Agricultural Education, Communications and 4-H Youth Development at Oklahoma State University to study the impact of student agricultural literacy in selected Agriculture in the Classroom (AITC) trained teacher classrooms in Arizona, Montana, Oklahoma, and Utah (Leising, Pense, & Portillo, 2001).

**Statement of the Problem**

Illinois ranks fourth in the nation for agricultural productivity (United States Department of Agriculture, 2015), yet the agricultural literacy of its elementary students is unknown. At the time of this writing, the researcher could find no evidence that Illinois elementary school students in K-5th grades have been tested statewide to determine agricultural literacy. Without an assessment of students’ level of agricultural literacy, it will be impossible to plan, develop, and progress in the delivery of a successful agricultural literacy program.

**Purpose of the Study**

The purpose of this study was to assess the agricultural knowledge of selected Illinois classrooms of public elementary school students in kindergarten through fifth grades that employ Agriculture in the Classroom (AITC) methods and materials. In order to determine the agricultural literacy rate of elementary school students, the researcher used the original instruments based on kindergarten through fifth grade standards and benchmarks of the Food and Fiber Systems Literacy Framework.
Objectives of the Study

1. Develop a demographic profile of schools that participated in the study.
2. Assess differences using posttest mean scores between AITC treatment group and control group in student knowledge about agriculture, before and after AITC instruction, for each grade grouping (K-1, 2-3, 4-5).
3. Assess differences in posttest mean scores between AITC treatment groups and control groups in student knowledge about agriculture, before and after AITC instruction, using the five thematic areas of the Food and Fiber Systems Literacy (FSSL) Framework for each grade grouping (K-1, 2-3, 4-5).
4. Assess theme posttest mean score gains between treatment and control groups in student knowledge about agriculture, before and after AITC instruction, for each grade grouping (K-1, 2-3, 4-5).
5. Develop a profile of student knowledge about agriculture, before and after AITC instruction based on pre- and posttest mean scores, for each grade grouping (K-1, 2-3, 4-5) by the five thematic areas of the Food and Fibers Literacy (FSSL) Framework.
6. Develop a demographic profile of students that will participate in this study.

Scope of the Study

The scope of this study encompassed classrooms of public elementary students in K-5th grade (N = 500) in Illinois; a total of thirty Illinois schools were selected.

Assumptions

The assumptions reported in the Final Report 2001-2003 AITC Report (Leising, Pense, & Portillo, 2001) were comparable to this study, and are stated as follows:
1. The instrument to be used will elicit accurate responses.
2. The respondents will fully understand the questions they will be asked.
3. The respondents will provide honest expressions of their knowledge.

**Limitations**

The limitations reported in the Final Report 2001-2003 AITC Report, Leising et al (2001), were comparable to this study, and are stated as follows:

1. Results cannot be generalized beyond the public elementary school students included in this study.
2. Sizes of public elementary schools may vary – some schools included in the study may be larger or smaller than most similar schools.
3. Access to some public elementary schools may be limited due to stringent screening of research proposals.
4. Administrators in some public elementary schools may refuse access due to a compressed curriculum and excessive mandated testing.
5. Access to some public elementary schools may be revoked due to changes in school administration.
6. Administrators in some public elementary schools may fail to respond to request for permission to conduct research.
7. Previous agricultural knowledge and interventions may exist or may have previously existed in some classrooms.
8. No other tests based upon an agricultural literacy framework, beyond the FSSL, currently exist for measuring concurrent validity.
9. There is no state-approved agricultural literacy curriculum for elementary school students.

10. Ethnic differences were not considered.

**Definition of Terms**

*Agriculture* – Agriculture is the production of agricultural commodities; including food, fiber, wood products, horticultural crops, and other plant and animal products. The term also includes the financing, processing, marketing and distribution of agricultural products; farm production supply and service industries; health nutrition and food consumption; the use and conservation of land and water resources; development and maintenance of recreational resources; and related economic, sociological, political, environmental and cultural characteristics of the food and fiber systems (Wallace, 1995).

*Agriculture, Food, Fiber and Natural Resources (AFFNR) Systems* - a term used synonymously with food and fiber systems.

*Agricultural Literacy* - possessing knowledge and understanding of food and fiber systems. An individual possessing such knowledge would be able to synthesize, analyze, and communicate basic information about agriculture (Frick, Kahler & Miller, 1991). Today’s definition has reflected current societal changes to be “a society with an understanding of agriculture and current economic, social, and environmental impacts [that] could lessen current challenges facing agriculture through good decision making along with the necessary support” (Kovar & Ball, 2013). Further, The American Farm Bureau Foundation for Agriculture in *Pillars of Agricultural Literacy* define agricultural literacy as knowledge of “all of the industries and processes involved in the production and delivery of food, fiber, and fuel that humans need to survive and thrive” (American Farm Bureau Foundation for
Agriculture, 2014). Finally, the National Agriculture in the Classroom in *Agricultural Literacy Logic Model* has defined an agriculturally literate person as one who “understands and can communicate the source and value of agriculture as it affects our quality of life” (Spielmaker, Pastor, & Stewardson, 2013).

*Agricultural Literacy Framework* — a systematic, multi-disciplinary, educational approach that promotes, fosters, and disseminates agricultural knowledge (Powell, Agnew, & Trexler, 2008).

*Agriculture in the Classroom (AITC)* – organized by the United States Department of Agriculture in 1981, AITC is a state-run organization addressing the agricultural education needs of the state’s students through partnerships of agriculture, business, education, government and dedicated volunteers to supplement and enhance the teacher's existing curriculum in a flexible educational program (Illinois Agriculture in the Classroom, 2015).

*Benchmark* – statement identifying expected or anticipated skill or understanding relating to Food and Fiber Systems at various developmental levels. It may be declarative, procedural, or contextual in the type of knowledge it describes (Leising, Igo, Heald, Hubert, & Yamamoto, 1998).

*Conversational Literacy in Agriculture, Food, Fiber and Natural Resources (AFFNR)* – a term used synonymously with agricultural literacy.

*Food and Fiber Systems* – a term used synonymously with the term agriculture (Igo, 1998).

*Food and Fiber Systems Literacy* – a term used synonymously with the term agricultural literacy (Igo, 1998).

*Food and Fiber Systems Literacy Framework* – a curriculum model delineating what a person should know to be agriculturally literate. The Framework is divided into five
thematic areas relating to agriculture: Understanding Agriculture; History, Geography and Culture; Science, Technology and Environment; Business and Economics; and Food, Nutrition and Health. It includes a narrative explanation of the concepts and information that an agriculturally literate person would understand. The Framework also includes grade-grouped standards with accompanying benchmarks (Igo, 1998).

*Standard* – describes what a student should know or be able to do relating to Food and Fiber Systems knowledge or understanding (Igo, 1998).

*Thematic Area* – one of five related topics, which comprise the overall subject of agriculture.
CHAPTER 2

REVIEW OF LITERATURE

The purpose of this chapter was to present a review of the relevant literature for this research study. This review of literature was divided into the following sections: (1) Introduction; (2) Agricultural Literacy Defined; (3) Research in Agricultural Literacy; (4) Agricultural Education Programs Contributing to Agricultural Literacy; (5) Agricultural Literacy Materials; (6) Agricultural Literacy Programs Outside the United States; (7) Agricultural Literacy Curricula Materials; (8) Learning Theories in Education; (9) Frameworks in Agricultural Literacy Education; (10) Agricultural Literacy Models; (11) Educational Measurement in Agricultural Education; and (12) Summary.

Introduction

Agriculture, the first science, impacts the food, health, stability, and economic well being of a nation and it’s inhabitants, yet it is poorly understood by the general public and especially, youth (Tisdale, 1991; Russell, McCracken, & Miller, 1990; Mayer & Mayer, 1974). With the migration from rural communities to urban areas, beginning with the economic panic of 1873, the first global depression brought about by industrialization, and continuing through the Dust Bowl, and the Great Depression, greater numbers of the population have distanced themselves from their agricultural roots to a predominately urban society (Blanke, 2016).

Supporting this distancing is the fact that only 1 percent of our population provided food, fuel, and fiber for Americans and peoples around the world in 2012, a figure down 3.1 percent from 2007 (United States Department of Agriculture, 2015). In 1988, the National
Research Council found many people to be two to three generations removed from farms and farming (National Research Council, 1988). Today, youth are further removed.

With this removal from our agricultural roots, the knowledge base about agriculture has dissolved for the vast majority of Americans over that time. Today’s population is ill-equipped to make well-informed decisions regarding the role agriculture plays in their lives (Mayer & Mayer, 1974; National Research Council, 1988; Tisdale, 1991). Additionally, the non-agricultural population has little to no understanding of the complexities involved with sustaining a viable agriculture system (Doerfert D. L., 2011). Further, this loss of understanding regarding agriculture’s complexities allows the poorly informed majority to impact policy decisions that may affect the agricultural industry’s ability to function efficiently and effectively in an increasingly competitive world market (National Research Council, 1988). Misconceptions about the importance of the role of agriculture in today’s global market comes as no surprise. While communicating clear and concise agricultural information is necessary, the public often understands and assimilates information, on which it bases its decisions and choices, through the professionals who are training the next generation of leaders and policy-makers, namely, educators (Elliot, 1999).

The National Research Agenda for the American Association of Agricultural Education (AAAE) outlined, under Research Priority One, an emphasis on understanding agriculture in a modern world through the need for an agriculturally literate society (Doerfert, 2011). Agricultural literacy education, beginning in kindergarten through adult levels, has been advocated for over 45 years (Russell, McCracken, & Miller, 1990; National Research Council, 1988; Swan & Donaldson, 1970).

Elementary students’ misconceptions regarding agriculture can be corrected when
students are taught about agriculture and its role (Swan & Donaldson, 1970). In support of this concept, the National Research Council’s Committee on Agricultural Education in Secondary Schools suggested “beginning in kindergarten and continuing through twelfth grade, all students should receive some systematic instruction about agriculture” (National Research Council, 1988, p. 2).

The field of agriculture is considered by Mayer & Mayer (1974) to be the model science, but is viewed by others, as a system. However it is labeled, agriculture is a complex field of study encompassing biology, economics, environment, sociology, politics, technology, and international trade and relations (Moore, 1987). Moreover, agriculture has become intensely specialized so that even those engaged in agriculture may know or understand little about the intricacies of inputs and resources needed outside their scope (Martin, 2015).

This review of literature addresses those topics related to agricultural literacy; namely, recognized definitions of agricultural literacy, programs, curricular materials, research, related educational theories, frameworks and educational measurements.

**Agricultural Literacy Defined**

In 1988, the National Research Council, defined an agriculturally literate person as having:

…an understanding of the food and fiber system that would include its history and its current economic, and social, and environmental significance to all Americans. The definition is purposely broad, and encompasses some knowledge of food and fiber production, processing, and domestic and international marketing. As a complement to instruction in other academic subjects, it also includes enough knowledge of nutrition to make informed personal choices about diet and health.
Agriculturally literate people would have the practical knowledge needed to care for their outdoor environments, which include lawns, gardens, recreational areas, and parks (National Research Council, 1988, p. 9).

A few years later, based on a survey of agricultural educators at land-grant universities, agricultural literacy was re-defined. The resulting definition stated:

“Agricultural literacy can be defined as possessing knowledge and understanding of our food and fiber system. An individual possessing such knowledge would be able to synthesize, analyze, and communicate basic information about agriculture. Basic agricultural information includes the production of plant and animal products, the economic impact of agriculture, its societal significance, agriculture’s important relationship with natural resources and the environment, the marketing of agricultural products, the processing of agricultural products, public agricultural policies, the global significance of agriculture, and the distribution of agricultural products” (Frick, Kahler, & Miller, 1991, p. 52).

Over the years, scholars have moved away from a knowledge-based understanding of agriculture to defining agricultural literacy in terms of “conversational knowledge, critical analysis, and value-based judgment” (Powell, Agnew, & Trexler, 2008, p.). Trexler (2000, pg. 5) further clarified conversational literacy as “the policies and values we hold as we define the depth and breadth of conversational literacy” in the American lexicon. Further, in an empirical study, literacy development was found to be built around “culturally based beliefs, values, and attitudes” leading to “the ability to make judgments based on culturally based norms” and asserted that “agriculture is a culture unto itself” which is reflected in today’s society engagement with agriculture (Meischen & Trexler, 2003, p. 43).
In April 2013, researchers, practitioners, and government officials met in Washington, D.C. to develop a National Agricultural Literacy Logic Model (Spielmaker, Pastor, & Stewardson, 2014, p. 1). In support, the model defined an agriculturally literate person as “a person who understands and can communicate the source and value of agriculture as it affects our quality of life” (National Agriculture in the Classroom, 2014, p. 1).

**Research in Agricultural Literacy**

The National Research Council found that too many Americans are uninformed about the social and economic impact agriculture plays in the United States (NRC, 1998). To address this concern, the agricultural education community focused its research into literacy programs, curricular materials, and agricultural knowledge at all age levels to refine its literacy efforts. Successive research projects led to content standards and a literacy framework to aid in planning, executing, and assessing agricultural literacy research and instruction.

**Overview of Agricultural Literacy Programs**

Agricultural instruction is not a recent innovation. Proponents of instruction in the field of agriculture date back to Socrates and Aristotle, as well as educational reformers like Froebel, Pestalozzi, Rousseau, and Comenius. Socrates, Pestalozzi, and Comenius all believed that peoples should learn about plant, animals, and the ways in which humans use them, early in life (Snowden & Shoemake, 1973). In 1749, Benjamin Franklin, founder of the American Philosophical Society, proposed that children be educated in agricultural instruction and early on published many essays on agricultural topics (Mercier, 2015; Snowden & Shoemake, 1973). The well-known agriculturalist, Thomas Jefferson in writing
to George Washington, on August 14, 1787, stated, “Agriculture … is our wisest pursuit, because it will in the end contribute most to real wealth, good morals & happiness” (Thomas Jefferson Foundation, 2016, p. 1). Human development theories formulated by Freud, Erikson, and Piaget suggest that children between the ages of six to eleven years develop opinions and ideas that last throughout their lifetime. They also determined that this is the same age range in which children should learn about their environment and society (Davis, 1983).

Hillison (1998) noted in the early parts of the 1900s, agriculture was utilized as a method for teaching science through a study of nature. Most of the states in the original American colonies had their own scientific societies focused specifically on agriculture (Mercier, 2015). Agriculture was considered an excellent delivery system for additional instruction at the elementary school level as reasoned by educational philosophers such as Froebel and Pestalozzi (Hillison, 1998). Where 18th century agricultural education was a means of providing farmers with the basic skills they needed to prosper on their farms, 19th and early 20th centuries observed that traditional agricultural education was focused on increasing production to sustain a growing and increasingly urban and industrial population (Mercier, 2015).

**Agricultural Education Organizational Programs Contributing to Agricultural Literacy**

Agricultural literacy programs existed prior to the 1988 National Research Council’s call for such a program in schools across the country.

**4-H (Head, Heart, Hands, and Health)**

In the late 1890s, vast numbers of young people were moving to the cities by the lure
of the potential labor market. The economic prosperity for future generations of rural children was bleak. With visionaries like Liberty Hyde Bailey, who promoted the concept of linking youth to nature and rural environments (Bailey, 1909, p. 309); O. J. Kerns, Illinois Agricultural Experiment Station, who founded Farmers’ Institutes to introduce farm and home topics and classes for rural youth; and Will B. Otwell, who offered premiums to boys for highest corn yields, the need has existed for the promotion of the field of agriculture (4-H, 2015, p. 1).

A. B. Graham, a school principal in Ohio, promoted vocational agriculture instruction in schools through clubs with officers, projects, meetings and record requirements. This was considered the founding of 4-H (4-H, 2015, p.1).

According to their website, 4-H is the nation’s largest positive youth development and youth mentoring organization in the U.S. today working through the Cooperative Extension System and the United States Department of Agriculture (USDA). This organization works in partnership with 110 universities; programs are research-backed and available through 4-H clubs, camps, afterschool and school enrichment programs in every county and parish in the U.S. (4-H, 2015, p.1). Additionally, independent 4-H Clubs are found around the globe in over 50 countries including Canada, Mexico, Africa, parts of Central and South America, Great Britain, Eastern Europe, Scandinavia, China, India, Japan, Australia, New Zealand, and Indonesia (http://www.4-h.org/about/global-network/).

The 4-H organizations recognize that young people are the drivers of future change with more than one billion between the age of 12 and 24 (4-H, 2015, p. 3). The United Nations projects the global population to swell to 9.75 billion people by 2050, and to 11.2 billion by 2100 (United Nations, 2015). This increase in humanity will demand greater food
production in the next 50 years than the previous 10,000 years combined (Borlaug, 2000). These young people are the future farmers who will need to do the job. Interestingly, more than 3.5 million girls and young women are involved in 4-H (4-H, 2015, p. 3).

**The National FFA (FFA)**

In 1928, 33 students from 18 states met in Kansas City, MO, to form the Future Farmers of America (FFA) (National FFA Organization, 2015, p. 1). According to their website, FFA’s mission was to prepare future generations for the challenges of feeding a growing population. The early founders and supporters taught that agriculture is more than planting and harvesting – it's a science, it's a business and it's an art (National FFA Organization, 2015 p. 1).

In 1935, under the guidance of G. W. Owens and J. R. Thomas, teacher-educators in agricultural education at Virginia State College, and Dr. H.O. Sargent, a federal agricultural education official, a national organization for African-American boys interested in agriculture formed in Tuskegee, Alabama, called the New Farmers of America (National FFA Organization, 2015, p. 2). By 1965, the NFA and FFA consolidated in recognition of shared missions for agricultural education.

According to its website, FFA’s vision is “students whose lives are impacted by FFA and agricultural education will achieve academic and personal growth, strengthen American agriculture and provide leadership to build healthy local communities, a strong nation and a sustainable world” (National FFA Organization, 2015, p. 1).

Tenney (1977) noted the National Future Farmers of America (FFA) Food for America program, implemented in 1975, and engaged high school agriculture students to share their agricultural knowledge with elementary school students. Their goal was to
educate the younger students’ understanding of the food and fiber chain from producer to consumer, a forerunner of the agricultural literacy movement. Other FFA chapter’s operated children’s barnyards and provided agricultural information to students in elementary schools (Tenney, 1977). Building Our American Communities (BOAC), a program initiated in 1971 to provide a vehicle for FFA members to make a direct contribution to their communities, also engaged in agricultural literacy efforts (Future Farmers of America, 1985).

**Agriculture in the Classroom (AITC)**

In 1981, the United States Department of Agriculture established an initiative focused on agricultural literacy called Agriculture in the Classroom (AITC) (Linder, 1990). The goal for all students to become agriculturally literate is not achieved by a single method. To be successful in this endeavor, the formation of partnerships combining intellectual, financial, material, and human resources are needed. Agriculture in the Classroom partners with various entities to accomplish this goal; including traditional agricultural high school programs, Farm Bureau, and industry organizations (Landeen, 2000).

The partnerships formed between education and profession was deliberate. In 1982, the USDA held a meeting in Washington, D.C. to discuss the need for agricultural literacy with representatives from agriculture, government, and education sectors. The representatives determined that the USDA would serve as a coordinator and communications link among the states, while allowing each state AITC program, autonomy. A model plan was developed to provide guidance for each state’s beginning efforts (United States Department of Agriculture, 1982).

Two of the first states to forge ahead with the AITC programs were California and Illinois. In both states, the Farm Bureau (FB) was instrumental in establishing and
continuing the success of the current programs. The Farm Bureau Foundations in the respective states called upon agricultural educators, agricultural extension agents, and other consultants to utilize their expertise to guide in the development of lessons to be shared with schools (Law, 1990; Landeen, 2000).

**California.**

California Ag in the Classroom (CFAITC) has been educating students about agriculture since 1986. In 2011, the California State Legislature recognized the CFAITC for its 25 years of service in promoting agricultural literacy to over 10 million California students through AITC programs and resources, which were used in 46% of all California schools (California Foundation for Agriculture in the Classroom, 2016).

Esparto, California high school agriculture teachers utilize a “Mentor Teacher” program to promote agricultural literacy district-wide by spending time and energy outside the traditional program. “Mentor students” were trained as aides or teacher’s assistants instructing elementary students under the supervision of the “mentor teacher” or the elementary classroom teacher (Schulte, Barnes, & Landeen, 1990, p. 11-12).

**Illinois.**

For many years in Illinois, the Illinois Farm Bureau was the state contact for Ag in the Classroom. In the fall, 2005, the Illinois Farm Bureau Agriculture in the Classroom program merged with Partners for Agricultural Literacy to form Illinois Agriculture in the Classroom. This merge combined the efforts of the Illinois Farm Bureau, Facilitating the Coordination of Agricultural Education (FCAE), University of Illinois Extension, Association of Illinois Soil and Water Conservation Districts, various Illinois commodity organizations and others (National Agriculture in the Classroom, 2014).
In their 2014-2015 achievements, Illinois AITC (IAITC) noted: there are active programs in all 102 Illinois counties, spending $2,198,986 at the local level; reaching 549,370 students directly through county programs; and training 576 teachers across the state through the Summer Agricultural Institutes (SAI) (Illinois Agriculture in the Classroom, 2016).

**Texas.**

Texas utilized Ag Science Fairs and Extension educators as avenues for agricultural literacy aimed at children (Blackburn, 1999). Also, promoting agricultural literacy, commodity groups contribute to the development and dissemination of educational materials promoting their individual products (Igo, 1998). These efforts by commodity groups are also found in other states as well.

Brown & Stewart (1993) noted that teaching a six-week module about agriculture not only increased agricultural knowledge, but also positively impacted middle school student attitudes about agriculture.

**National Agriculture in the Classroom Programs (NAITC)**

By 1990, thirty-two states (64%) reported agricultural literacy programs in at least one grade level (Hall D. E., 1991). State programs are organized and staffed differently throughout the nation. State programs may be housed within departments of agriculture, agricultural organizations, universities, or private nonprofit foundations. Most state programs have formed educational nonprofit organizations, which have the benefit of a tax-deductible status. Every state in the nation has some form of agricultural literacy program in place. In 2014, the National Agriculture in the Classroom Organization (NAITCO) and
member states reached 171,000 teachers and 5,299,566 students (National Agriculture in the Classroom, 2014).

In 2010, through a grant funded by National Institute of Food and Agriculture (NIFA), the National Agriculture in the Classroom in cooperation with University of Minnesota under project director, J. G. Leising, the developer of the FFSL, developed a National Agricultural Literacy Curriculum Matrix. The Matrix, as it is called, is an online, searchable, and standards-based curriculum map for K-12 teachers and contextualizes national education standards in science, social studies, and nutrition education with instructional resources linked to the Common Core Standards. The website allows educators to print lessons and activities or store them in a personal online “My Binder” associated with the Matrix (National Agriculture in the Classroom, 2014).

In 2012, the National Agriculture in the Classroom (NAITC) organization’s executive committee became responsible for working as a volunteer network of state contacts elected by their NAITC members in providing guidance to strengthen state programs. The NAITC organization encourages and supports state programs and their staff. NAITC challenges and encourages state AITC program leadership to adopt minimum standards and expectations for official NAITC State Contacts (National Agriculture in the Classroom, 2014).

The USDA sponsored an extensive evaluation of AITC using a census survey of each state’s AITC director. AITC respondents were from all 50 American states, Guam and the Virgin Islands (Curtis, Hellerich, Hipsley, Smith, & Traxler, 1988; Meischen & Trexler, 2003). The study found the apparent success and strength of AITC comes from its grassroots organization, and the fact that educators are an important part of the movement.
Since 1981, AITC has focused its efforts toward connecting agriculture with education, and is regarded as a flexible educational program designed to supplement and enhance the teacher’s existing curriculum (National Agriculture in the Classroom, 2014; Curtis, et al., 1988).

**Summer Agriculture Institutes (SAI) Program**

An agricultural literacy program for K-12th grade teachers called *Summer Agricultural Institute* was implemented by Oregon State University using teacher curricula, including agriculture as the context for instruction (Balschweid, Thompson, & Cole, 1998).

In Illinois, *Summer Agricultural Institute*, is designed for educators who wish to expand their curriculum to include topics related to agriculture-the world’s food and fiber system. The course focuses on how to integrate available resources and hands-on activities about agriculture and the environment into an existing classroom curriculum. Educators can earn professional development credits or college credit for attending. Scholarships are often provided to educators to cover or defray the cost through the local county Farm Bureau.

**Agricultural Literacy Materials**

**AITC Materials**

Educators are able to receive agricultural literacy materials from the local County Ag Literacy Coordinator or the local Farm Bureau offices, free of charge or available online, in the form of Ag Mags (a four page agriculture based magazine), mAGic (multidisciplinary AGricultural integrated curriculum) kits, Agri-Learning (agriculture and learning linked together in the study food, plants, and animals) kits, books, SMART board lessons and activities, Terra Nova, interest Make-n-Takes and other activities. In Illinois, educators have access to all the above-mentioned materials as well as technology lessons in QR Codes,
Augmented Reality app (Aurasama), and Kahoot! (a free game-based learning platform) through the Illinois Agriculture in the Classroom website under “Teacher Resources” (http://www.agintheclassroom.org/TeacherResources/).

**Project Food, Land & People, Inc. (FLP) Materials**

Other agencies have also tackled the issue of agricultural literacy. Project Food, Land & People, Inc. (FLP), a nonprofit educational organization, provides materials that have proven effective for integrating an agricultural curriculum in science and social studies classes (Cardwell, 1999). Established in 1989, a group of 50 professionals concerned about students, educators and citizens understanding the crucial relationships between agriculture, natural resources, and people of the world, developed a collection of related lessons for Pre-K-12th grades. Project FLP’s science and social sciences based curriculum, *Resources for Learning*, consists of 55 hands-on lessons ranging from environmental science and stewardship to human populations and land use issues. Lessons are available for purchase on their website, http://www.foodlandpeople.org/ordering/.

**Agricultural Literacy Programs Outside the United States**

Few programs outside the United States address the issue of agricultural literacy as rigorously as the proponents in this country, yet interest and concern for agricultural literacy programs are growing. Some global studies focused attention on adult training programs rather than children’s programs. However, this suggests there is a greater need for agricultural literacy education and instruction to begin at the elementary school levels.

**Great Britain**

A recent study of students across England commissioned by the Year of Food and Farming found a profound decline in children’s contact with the countryside. In fact, one in
five children, or nearly one million children, have no contact with the land or any idea of where their food comes from (Department for Environment, Food and Rural Affairs (Defra); Department of Health; Department for Children, Schools and Families (DCSF), 2007).

Defra found between 2000 and 2005 overnight visits to England’s countryside declined by 38% (Sigman, 2007). Sigman (2007) also found an increasing number of “concrete kids” who view life on a computer or TV instead of being outdoors or much less in the countryside.

Taiwan

Straybirds, launched by the Taiwan Council of Agriculture (COA) in 2006, is considered the most important agricultural trainee program aimed at young people in Taiwan (Wang & Huang, 2010). Inspired by the popular 1901 German movement, die Wandervögel, the program encourages young people living in urban areas to move to more rural areas with natural environments and pursue more independent lifestyles (Mohler, 1972). Facing both an aging agricultural work force and agricultural labor shortages, Straybirds offers a solution faced by Taiwan and other countries facing farm labor shortages (Wang & Huang, 2010). Straybirds provides informal government-organized agricultural training courses designed to enhance agricultural literacy and disseminate the value of a rural lifestyle (Hele, 2005; Liu & Ho, 2004; Deeds, 1991; Russell, McCracken, & Miller, 1990).

In 2011, following on the heels of the success of Straybirds, the Council of Agriculture in Taiwan introduced The Farmer’s Academy, a virtual academic network established to cultivate the next generation of farmers. The launch of Agriculture 3.0 offered
cloud-computing solutions for transferring agricultural knowledge and has brought stability and growth to the nation’s agricultural sector (Council of Agriculture, 2012).

**Australia**

In a recent study, American agricultural education student teacher researchers spent ten weeks in New South Wales, Australia in an international student teacher program. The study found that culture, stereotypes, language, teaching methods, student performance, and community unification can be impacted through an international exchange of ideas and teaching methods (Bunch, Stephens, & Hart, 2011).

**Poland**

Polish researchers have found that there is an urgent need for a continual transfer of knowledge to the farmers in that region with the most significant role being played by school education, as well as training and workshops (Zuzek & Wielewska, 2015).

**France**

Montpellier, France has seen agriculture “reinterpreted” inside cities (Torreggiani, Dall'Ara, & Tasinari, 2012). “Shared garden”, or collective garden concept in France, found their beginnings in the North American community garden movement (Pashchenko & Consales, 2010). The study found that collective gardens provided meaningful environmental and agricultural education elements to urban life and help reconnect urban life to agriculture (Scheromm, 2015).

**Spain**

As in France, allotment gardens, managed and cared for by single gardeners or their families, and allotment gardens or “community gardens”, to use the American vernacular, are found in Spain. The study found 95.5 percent of the interviewed participants stated that
urban gardens had the most impact on their well-being through learning and education (Camps-Calvet, Langemeyer, Calvet-Mir, & Gomez-Baggethun, 2016).

**European Modules and Mobility in Agricultural Education (EMMA)**

The primary aim of the EMMA project is to conduct educational activities by providing opportunities for both experienced teachers and student teachers to work together in international teams and develop educational outputs related to agriculture and agricultural education. Two one-week courses were held for experts who produced the training tool of the European Modules for student teachers. This tool was used during the training period at the one-month mobility sessions at each partner institution across the European Union (Czech University of Life Sciences, 2009). This program is similar to the one-week Summer Agriculture Institutes (SAI) held annually across the United States.

These global studies suggest the importance agricultural literacy and training is a growing and vital concern in embracing knowledge of and about agriculture as an important component in today’s societies, promoting social cohesion, quality of life, healthy lifestyles and food choices in various parts of the world.

**Agricultural Literacy Curricula Materials**

The NRC (1988) report noted that few systematic efforts existed to include agricultural literacy to students of any age. Students may have received some instruction about agriculture, but the report noted, “the material tends to be fragmented, frequently outdated, usually only farm oriented, and often negative or condescending in tone” (NRC, 1988, p. 9). At that time, assessment of agricultural literacy instructional material was in its infancy.
A precedent setting study utilizing a Delphi technique established a working definition of agricultural literacy classifying eleven broad agricultural subject areas that could be utilized to develop a framework for expanding agricultural curricula (Frick, et al., 1992). The eleven subject areas addressed in agricultural literacy are:

1. Agriculture’s important relationship with the environment
2. Processing of agricultural products
3. Public agricultural policies
4. Agriculture’s important relationship with natural resources
5. Production of animal products
6. Societal significance of agriculture
7. Production of plant products
8. Economic impact of agriculture
9. Marketing of agricultural products
10. Distribution of agricultural products
11. Global significance of agriculture (p.54)

Frick’s work was the foundation for many subsequent research studies in agricultural literacy.

A later study reported an agricultural literacy framework developed using a modified Delphi technique and validated by panelists representing a broad spectrum of agriculture and education interests in California (Leising & Zilbert, 1994). A tri-state study of K-8th grade students (Igo, Leising, & Frick, 1999) found it was possible to increase student agricultural knowledge by utilizing instruction based on the Food and Fiber Systems Literacy Framework (FFSL) standards and benchmarks. Further, the researchers found it
possible to infuse agricultural education into core academics using the FFSL’s five thematic areas, standards, and benchmarks as guides for instruction and use.

With this call for agricultural literacy instruction, Pals (1998a) found Idaho teachers typically incorporated agriculturally related materials into the science core subjects. Further, the researcher found respondents were interested in attending agricultural workshops for science credit and were interested in receiving lists of suggested resource materials to provide agricultural instruction according to the Idaho AITC program. In a related study, Pals (1998b) evaluated the Idaho AITC Curriculum Guide. Only 11 units in the guide were being taught yearly by each of the 128 teachers who utilized the guide. The teachers indicated science, health and nutrition, and social studies topics were frequently presented. However, the effective use of materials did not necessarily predicate prior agricultural knowledge.

In Ohio, a survey of 750 randomly selected fourth grade teachers verified the AgVenture Magazine was an effective instructional aid in teaching students about agriculture (Swortzel, 1997). Teachers reported positive perceptions about the magazine stating it was used primarily in social studies classes approximately nine hours per year.

Perry (1998) surveyed 1,048 Oregon state teachers and queried them regarding 19 identified curricula commonly used for agriculture and natural resources education. Over 80% of the respondents acknowledged Future Farmers of America (FFA) and 4-H as the most commonly known programs, even in urban areas. The SOLV (Stop Oregon Litter & Vandalism) program was known by 50% of the survey respondents. More than 30% of the teachers responding to the survey knew of Project WILD, a wildlife-focused conservation education program for K-12 educators and their students (Project WILD, 2016), Project
Learning Tree, an environmental education program for Pre-K-12 educators and their students (Project Learning Tree, 2010), and Salmon Watch. Perry (1998) found that K-5 teachers and science teachers best knew Project WILD and Project Learning Tree, while Salmon Watch was best known by middle and high school teachers.

Lesser-known curriculums, GREEN (Global Rivers Environmental Education Network) and The Wonders of Wetlands, were known to 10% of surveyed teachers. The Summer Ag Institute (SAI) was known to 13% of respondents, and rural teachers were two to three times more familiar with this program than urban teachers. The study further revealed that science teachers and teachers from rural areas tended to be more aware of agricultural and natural resources curricula.

Facing educational accountability demands and increased student performance, teachers often select curricula that will best prepare students for success on standards-based achievement tests (Bellah & Dyer, 2006). Teachers are more concerned with what to teach in order to meet the standards and assume positions as “gatekeepers” in selecting and delivering subject matter to students (Barab & Luehmann, 2003).

There is not a lack of available curriculum resources to assist teachers in integrating agricultural concepts and providing contextual experiences for students. The challenge is how to shape these components into a deliverable, student-centered package (Bellah & Dyer, 2006).

Assessment of Knowledge About Agriculture

Kovar and Ball (2013) undertook a synthesis of two decades of publications regarding agricultural literacy research since the publication of Understanding Agriculture—New Directions for Education (1988). The researchers sought to determine
where agricultural literacy was published, which populations were targeted, the purpose of the research, and the finding of the agricultural literacy studies between 1988 and 2011. A total of 49 studies were identified—17 studies in the Journal of Agricultural Education, seven studies in the North American Colleges and Teachers of Agriculture (NACTA), three studies in the Journal of Extension, 18 studies in national or regional American Association for Agricultural Education (AAAE) conference proceedings, and four miscellaneous studies. Elementary teachers and students were the most frequently targeted populations. The purposes of the identified studies were coded into three specific areas: (a) assess agricultural literacy; (b) test the effectiveness of an agricultural literacy program; and (c) develop a framework or guide to assist educators.

Kovar and Ball (2013) found while the programs were successful in increasing agricultural literacy, many of the assessed populations were found to be agriculturally illiterate. The researchers noted further research is warranted to explain areas of deficiency in agricultural literacy (Kovar & Ball, Two Decades of Agricultural Literacy Research: A Synthesis of the Literature, 2013).

**K-8 Student Assessment of Knowledge About Agriculture.**

The earliest study focusing on elementary and middle school students’ knowledge about agriculture, or agricultural literacy, found that less than 30% of the 2000 Kansas student respondents could correctly answer basic agricultural questions (Horn & Vining, 1986).

Perritt and Morton (1990) reported that youth in urban and suburban areas had little exposure to agriculture. Local FFA members presented a five-day curriculum to 120 fourth graders in Nacogdoches, Texas, using agricultural examples to assist the teacher. Three
months following instruction, a quiz was given to the participating students with 89% of the fourth graders passing the quiz. The researchers concluded that presenting a positive association with agriculture to the public sector was a challenge for agricultural educators (Perritt & Morton, 1990, p. 15).

Williams and White (1991, p. 9) found student knowledge about agriculture of all fifth, eighth, and eleventh grade levels in rural Oklahoma County was deemed a “low” level of literacy, a score below 50 was considered low. Students in this study had an overall mean score of 32.62. While the scores were not surprising, it was disturbing in a state where agriculture was the second largest industry in terms of income generated. The study also compared students who participated in agricultural organizations, specifically 4-H and FFA. Students in fifth and eighth grades had higher scores than non-participating students (Williams & White, 1991, p. 10).

Brown and Stewart (1993) assessed Missouri middle school students’ knowledge about agriculture and attitudes regarding the subject. Results from the pre- and posttests indicated there was a change in agricultural knowledge and attitude toward agriculture after students received instruction about agriculture. However, the length of time students received agricultural instruction (6 to 18 weeks) did not affect a change in their agricultural knowledge or attitude toward agriculture.

Herren and Oakley (1995) evaluated Georgia’s Ag in the Classroom curriculum, which began in 1987. The researchers found that second and fourth grade students receiving AITC instruction demonstrated significantly greater increase in agricultural knowledge scores over the control group. Students of teachers with little or no farm experience exhibited significant differences in their scores as a result of the AITC program.
Additionally, data revealed the AITC program was effective whether students lived in urban or rural environments; thus, agricultural literacy was an issue regardless of locale.

In another study, Swortzel (1996) studied Ohio fourth grade students’ knowledge about animal agriculture. Utilizing the *AgVenture Magazine*, the researcher integrated animal agriculture instruction into the curriculum over a period of four weeks. Using a pre-experimental pre-posttest design, he found students scored an average of 9.6 points higher on the posttest than the control group. Contrary to the study conducted by Herren and Oakley (1995), students living in urban areas had higher gains between pretest and posttest scores.

Known as the “cheeseburger” study, Trexler (1997) concluded that participants who lived solely in urban environments did not consider where the food they consumed came from, but only considered it on the basis of hunger and the need for food. The participant who lived in closest vicinity to where food was produced was more aware of the living things, like cattle, that became his/her food. Trexler also discovered that school-based understandings in science regarding the agri-food system varied widely from well developed, to partial, to non-existent. These findings are very similar to those of Sigman (2007) regarding the ambivalence of “concrete” children to where they food comes from.

Additionally, Trexler (1997) found that elementary students with limited exposure to production agriculture believed farms were small (the size of two football fields) with one farmer growing multiple varieties of crops in adjacent rows. Tevis (1996) agreed that “stereotypes about agriculture remain a stumbling block” (p. 64) characterizing the perception problem facing American agriculture.
DeWerff (1989) suggested that learning about agriculture should begin at younger ages. The researcher found students see agriculture in a narrow sense, i.e. a farmer, a cow, a pig, etc., along with other stereotypes (p.15). Additionally, DeWerff noted the problem is further complicated by the successful productivity of the American farmer with less land needed for agriculture allowing for the growth of residential areas. “It is a small wonder that few Americans have an accurate understanding of modern agriculture” (p.14).

A recent study found elementary students understand where their food comes from, namely farms, but few understand details about the agri-food system and often have misconceptions that may hinder acquisitions of new schema (Hess & Trexler, 2011).

The first study of its kind in the field of agricultural education, Igo, Leising and Frick (1999) assessed K-8 student knowledge about agriculture before and after receiving instruction based on the completed and validated Food and Fiber Systems Literacy (FFSL) Framework (Leising, et al., 1998). Based on the five themes of the Framework with standards and benchmarks for each theme, the researchers developed a series of lessons and instructional activities for teachers to utilize as examples for incorporating agricultural concepts into their classroom curricula. Teacher training contained two phases, and students were pretested prior to a treatment being administered. The results of this three-state quasi-experimental study indicated the pre-posttest data increased agricultural knowledge significantly. Additionally, a positive relationship was found between the number of teacher-reported connections to the FFSL and increases in student agricultural knowledge (Igo, Leising & Frick, 1999).

In a related study, Leising, Pense and Igo (2001) utilized a quasi-experimental nonequivalent control group design to compare differences between treatment and control
groups by grade grouping, FFSL Framework themes, and teacher-reported instructional connections to the FFSL in a three-states, specifically, Nebraska, Oklahoma, and Montana. Nebraska, the control group, exhibited greater student agricultural knowledge than the Oklahoma/Montana treatment group on the pretest, but no significance was observed between the mean scores for any of the four grade groupings. However, the Oklahoma/Montana treatment group revealed a significant increase in student agricultural knowledge in three of the four grade groupings through integrated lessons based on FFSL standards and benchmarks.

The FFSL Framework was organized around five thematic themes: Understanding Agriculture; History, Culture, and Geography; Science and the Environment; Business and Economics; and, Food, Nutrition and Health (Leising, et al., 1998). In this study, three thematic themes produced the greatest statistically significant differences in the treatment group: Understanding Agriculture; History, Culture, and Geography; and Science and Environment. This difference was apparent in the 2-3, 4-5, and 6-8 grade groupings. The treatment group for grade groupings 2-3 and 4-5 were statistically different in Business and Economics; and in grade groupings 1-2 and 2-3, Food, Nutrition, and Health was significantly different. In the control group, there was no statistical differences between the pretest and posttest scores for any grade grouping in the first two thematic areas: Understanding Agriculture; and History, Culture, and Geography. However, the control group did yield a statistical difference in a single grade grouping for the remaining three thematic areas: Science and Environment (2-3 grade grouping); Business and Economics (2-3 grade grouping); and Food, Nutrition, and Health (K-1 grade grouping) (Leising, Pense, & Igo, 2001).
Researchers found that unlike the previous year of the study, there was no statistically significant correlation between test score differences and the number of instructional connections led by teachers in the treatment group sites (Leising, Pense, & Igo, 2001).

**Secondary School Student Assessment of Knowledge About Agriculture.**

In a study conducted by Kovar and Ball (2013), the researchers found that in the last two decades, between 1988-2011, there were five studies focused on high school students. The studies on high school students in these early studies used instruments developed around agricultural areas found to be important for agricultural literacy, but did not involve the development of an instrument for 9-12 grades to assess agricultural literacy.

Pense (2002), in collaboration with others, developed a validated instrument based on grades 9-12 benchmarks of the FFSL Framework of standards and benchmarks for assessing agricultural literacy of this population of students in general education and agricultural education classes. The instrument used to assess student agricultural knowledge in K-8 grades was used as a model in the instrument development process for 9-12 grades (Pense, 2002). Pense (2002) found general education students in rural schools to have the lowest mean agricultural knowledge scores when compared to their urban and suburban counterparts. Additionally, the agricultural education students overall mean scores on the agricultural knowledge test did not differ significantly from the general education students’ mean scores. However, the suburban school groups had the highest mean scores while the rural school groups scored the lowest.

Using the 1990 Frick study as a foundation, Frick, Birkenholz, Gardner, and Machtmes (1995) found rural high students were most knowledgable in natural resources
concepts and least knowledgable in agricultural plants. The urban inner-city high school students were also found to be most knowledgable in natural resources and least knowledgable regarding agricultural policies. The study reported that urban inner-city high school students had overall lower mean knowledge scores as well as overall less positive perceptions toward agriculture than rural high school students (Frick, et al., 1995).

In a related study, Frick, et al. (1995) used the instrument developed in the 1990 Frick study to assess the agricultural knowledge, perception related to agriculture, and demographic information of 550 mid-western 4-H students. The respondents were most knowledgable about natural resources concepts and marketing of agricultural products. Their lowest mean score knowledge came in the plant concept areas. 4-H members were found to have the most positive perception mean scores for natural resources and animal science concept areas. The least positive perception score was agricultural policy concept area. The study found 4-H members had high overall mean levels of knowledge of agriculture for all concepts areas, but scores varied widely (Frick, et al., 1995).

According to a study by Frick and Wilson (1996), Montana’s Native American high school students had overall moderate to high levels of knowledge about agriculture. The instrument developed by Frick (1990) was utilized to assess knowledge and perception of agriculture in seven content areas. The Native American students perception toward agriculture was positive, but a wide variance of perception within the seven concept areas was found (Frick & Wilson, 1996).

Kovar and Ball (2013) noted that changes in the agriculture industry, including the financial crisis of the 1980s, the rise of corporate farming, as well as the changes in technology and farming trends, such organic farming and ethanol production to precision
agriculture and environmental stewardship warrants a new framework to assess agricultural literacy.

**Teacher and Adult Assessment of Knowledge About Agriculture.**

Kovar and Ball (2013) noted that teachers were identified in ten studies from 1988 to 2011. Of this number four studies were of elementary school teachers, two studies focused on high school teachers, and an additional four studies examined K-12 school teachers. Another six studies examined non-educator adults, including parents, officials, administrators, or other community leaders. These studies typically examined knowledge and perceptions about the field of agriculture. This is vital as education and, more importantly, the educators were determined to be the tool that would both establish and promote the growth of concepts to insure that citizens would learn how to be responsible citizens and secure the United States as a nation for future generations (Gelbrich, 1999).

Terry (1990, p. 9) stated “The role of the teacher in teaching students about agriculture cannot be understated. In most programs of agricultural literacy that have been proposed, the regular classroom teacher would be responsible for delivering the material to the students”.

In the Texas public school system, science and social studies were typically introduced in the fourth grade. (Terry, Herring, & Larke, 1992). In this study, researchers surveyed fourth grade teachers to determine their knowledge and perceptions levels of agriculture. Additionally, the researchers sought to examine the extent to which teachers used resources in their everyday curricula that were agricultural in nature. The study determined that teachers have inacurrate perceptions and limited knowledge about
agriculture. The researches concluded that efforts were needed to improve teacher perceptions and increase teacher technological knowledge about agriculture.

In a related study of Missouri secondary teachers, Harris and Birkenholz (1993) found educators to be knowledgable about agriculture and to have positive attitudes toward agriculture. The researchers found teachers more knowledgable about agriculture were more likely to include agricultural examples in their lessons (Harris & Birkenholz, 1993).

Cox (1994) developed a five-part mail survey to ascertain fourth grade educators perceptions, knowledge, concepts taught, and assistance used to integrate agricultural related concepts into their classrooms. The researcher found respondents did not associate agriculture with science, but identified agriculture as the production of animals, plants, and food. Ten questions related to plant growth and development, ecology and environment, nutrition and food sources, and entomology were answered incorrectly by the majority of teachers. Plant science activities were the most widely completed units of instruction. Primarily, teachers relied on textbooks and periodicals for agricultural information. The study concluded increased education and marketing to educators should accentuate the relationship of agriculture to the various fields of science (Cox, 1994).

Based on the eleven concept areas of agricultural literacy proposed by Frick, Kahler, and Miller (1991), science educators in Arizona middle and high schools were found to be illiterate. Wallace noted that science teachers most understood environmental issues and their relationship to agriculture (Wallace, 1995).

Balschweid, et. al (1998) debuted an agricultural literacy program aimed at Oregon’s non-agricultural K-12 teachers through Oregon State University. In verifying the effectiveness of the program, the researchers noted teachers in the program used agriculture
extensively as a context for instruction. Barriers to implementation of agricultural information into the curriculum were not due to negative attitudes or lack of knowledge regarding agriculture, but were time constraints and inadequate supplies and materials (Balschweid, Thompson, & Cole, 1998).

Wilhelm, Terry, and Weeks (1998) utilized a mailed questionnaire to K-6 teachers coded into two groups of those having attended an Oklahoma AITC SAI and those who had not to determine whether AITC influenced the inclusion of agriculture in their instruction. The teachers who attended a SAI were found to include more agriculture related topics than those who did not attend. Additionally, SAI teachers reportedly used more AITC materials significantly more and incorporated agriculture lessons into the core areas of language arts and information skills than their non-attending counterparts. The researchers not only recommended the continuance of AITC SAI, but also recommended additional methods of intensive teacher development be provided to allow a larger number of teachers to attend (Wilhelm, Terry, & Weeks, 1998).

In a 2003 study, Knobloch and Ball, examined teachers’ and agricultural literacy coordinators’ beliefs related to the integration of agriculture into instruction. The study found beliefs act as a powerful filter in how teachers interpret new phenomena (Pajares, 1992). Teachers participating in an Illinois SAI for teachers interpret their professional development experiences through beliefs they hold about teaching, learning, educational standards, integration and agriculture (Knobloch & Ball, 2003). Knobloch and Ball (2003) found beliefs play a vital role in how teachers interpret new knowledge and experiences and the value the teachers place upon new knowledge and experiences.
The teachers participating in this study taught English, reading, math, social science, and science to first through fifth graders. The study estimated that only 3% of the elementary teachers in Illinois have participated in a SAI (Knobloch & Ball, 2003). The study revealed that food, consumer, and general agricultural topics were taught about once a year. Teachers appeared to need more professional development opportunities to develop activities, identify resources, and integrate agricultural topics to the Illinois Learning Standards to explain ag-related topics to students (Knobloch & Ball, 2003).

Barriers to integration of agricultural topics into the daily curriculum included lack of time, need for instructional resources, in-service education, and assistance for incorporation into daily instruction (Knobloch & Ball, 2003). These barriers to inclusion of agricultural topics are similar to those reported by Wilhelm, Terry, and Weeks (1998) as well as Balschweid, Thompson, and Cole (1998).

Agricultural literacy is a current issue, not only in American society, but globally. Knowledge and understanding of agriculture is necessary as the global population expands compounding issues of feeding the world, while establishing and maintaining a sustainable, viable agriculture system (Kovar & Ball, Two Decades of Agricultural Literacy Research: A Synthesis of the Literature, 2013).

**Learning Theories in Education**

There are numerous theories related to human learning which have evolved over time.

As with other areas of research, different theories have arisen as researchers have concentrated on different types of learning. Some research has focused on skill acquisition such as learning to read, write and, yes, type (Anderson, 1981; Bryan & Harter, 1897; LaBerge & Samuels, 1974; NRC 2000). Other researchers have focused on understanding
learning and how learning effects schema formation and transfer (Anderson & Pearson, 1984; Judd, 1908; NRC, 2000; Wertheimer, 1959). Still other researchers investigate the emergence of new ideas through “bumping up against the world” and through interactions with other people (Carey, 2000; Karmiloff-Smith & Inhelder, 1974; Papert, 1980; Vygotsky, 1978).

Learning theorists have examined different settings for where learning can occur, such as preschools, traditional schools, experimental laboratories, informal gathering venues, and home and workplace settings. In the past 30 years, research has moved out of a “lab only” setting to more complex surroundings like classrooms, schools, and districts (Brown A. L., 1992; Collins, 1992; Linn, Davis, & Bell, 2004; Resnick, 1987).

In Learning Theories and Education: Toward a Decade of Synergy, researchers focused on several key traditions of thinking that may influence and change how future educators and scientists are trained. The researchers focused on three major areas of research, specifically: (1) implicit learning and the brain; (2) informal learning; and (3) formal learning. Typically, these areas worked independently of one another. However, when researchers in these fields attempted to apply the findings directly to education, the results were disappointing (Bransford, et al., 2005).

Bransford, et al. (2005) found that successful efforts to understand and drive human learning required a simultaneous emphasis of informal and formal learning and implicit ways in which learning occurs regardless of the environments. Utilizing these traditions may create a more vigorous understanding of learning that can inform the learning environments that allow students to succeed in the quickly changing world of the twenty-first century (Darling-Hammond & Bransford, 2005; Vaill, 1996).
Implicit Learning

Implicit learning refers to information that is acquired effortlessly and often without conscious recollection of the learned information or having acquired it (Reber, 1967; Graf & Schacter, 1985). Bransford, et al. (2005) interest in implicit learning revealed the view that: (a) implicit learning takes place in both informal and formal educational settings, (b) implicit learning involves skill learning which plays a vital role in other types of learning, and (c) implicit learning plays an essential role in learning about language and people across the lifespan.

Implicit learning arises in many areas; it influences social attitudes and stereotypes regarding gender and race (Greenwald et al., 2002), motor response time tasks (Nissen & Bullemer, 1987), syntactic language learning (Reber, 1976), phonetic language learning (Kuhl, 2004), and young children’s imitative learning of their culture, behaviors, customs, and rituals of their social groups (Meltzoff, 1988; Tomasello, 1999).

Bransford et al. (2005) noted that our lifelong learning about language and people begins before kindergarten, and in some cases important foundations are established in the first year of life. In these areas, parents are the first "teachers" and much is absorbed through spontaneous and unstructured play.

Brain-Based Learning

Modern neuroscience research notes learning in an alive, awake brain, reveals the impact of experiential learning before it can be observed in behavior (Bransford, et al., 2005). Brain studies link neural underpinnings to behavioral function, helping us understand learning and may alter what we do in classrooms. Bransford, et al. (2005) found that future
research needs to combine educators and neuroscientists to study learning across settings and will take a great deal of collaborative work.

Neurobiological studies, however, do provide crucial knowledge that cannot be obtained through behavioral studies. There are three justifications for adding cognitive neuroscience to tools for developing a science of learning.

First, science of learning will involve understanding not only when learning occurs, but also understanding how and why it occurs. The how and why of learning are exposed if we discover it’s neural underpinnings and identify the internal mechanisms that govern learning across ages and settings (Bransford, et al., 2005).

Second, neural learning often precedes behavior (Tremblay, 1999), offering a chance for scientists and educators to reflect on what it means to “know” and “learn”.

Third, better categorization of behaviors should allow the educational strategies and policies that affect learning to be usefully grouped in ways not obvious absent the study of brain function (Bransford, et al., 2005).

In education, teaching should be multifaceted in order to engage students to express visual, tactile, emotional, and auditory responses and may require the reshaping of learning organizations to exhibit the complexities found in life (Caine & Caine, 1990, p. 69). Caine and Caine (1989) noted this requires three interactive elements: relaxed alertness, immersion, and active processing.

Relaxed alertness occurs when the brain’s preference for challenge and its search for meaning requiring a delicate balancing act are met (Caine & Caine, 1990, p. 69).

Teachers should promote the immersion of their students in appropriate experiences because all learning is experiential (Caine & Caine, 1990, p. 69). The researchers noted that
teachers can make their classrooms “real-world communities”, where the students are given responsibilities for handling ceremonies and supervisory functions.

Active processing allows students to take charge of learning through questioning and genuine reflection in a way that is personally meaningful (Caine & Caine, 1990, p. 69). Caine and Caine (1990, p. 69) noted that this allows students to recognize and deal with their own biases and attitudes and develop thinking skills and logic as they create connections to what they are learning.

**Informal Learning**

Informal learning can be learning that occur in homes, on playgrounds, among peers, and in other situations where a designed and planned educational agenda is not authoritatively sustained over time (Bransford, et al., 2005, p. 25).

Seventy-nine percent of a child’s waking activities, during their school age years, are spent in non-school pursuits—interacting with family and friends, playing games, consuming commercial media, and so on (NRC, 2000).

Informal learning research seeks to study how people learn in “their” informal settings with sustained attention paid to “indigenous meanings and local phenomena” (Emerson, 2001, p. 136).

Educators need to better understand the specific resources that young people bring to school from their informal activities as well as how school-based knowledge is utilized to further informal learning (Bransford, et al., 2005, p. 41).

**Formal Learning**

Formal learning in education is a cyclic process of research, design, and evaluation of current educational programs to create the most effective learning environments in
in which to help students learn.

From a learning perspective, formal learning is also important to understand the social and cognitive processes that support the kinds of competencies educators want students to develop (Bransford, et al., 2005, p. 43).

Bransford, et al (2005, p. 50) noted that central to the goal of helping students achieve important learning outcomes is to clarify what success looks like (Wiggins & McTighe, 1997). This is important both for issues of summative assessment (seeing how students perform at the end of some course or program of study) and formative assessment (creating measures that provide feedback to students and teachers) plus opportunities for revision that speed learning progress over time (NRC, 2001; Darling-Hammond & Bransford, 2005).

However, a number of researchers suggest that typically used assessments provide useful yet incomplete pictures of the kinds of skills, knowledge, and attitudes needed for success in the twenty first century (Bransford, et al., 2005, p. 51). And the debate continues.

**Learning Theories Related to Agricultural Education**

**Authentic Learning**

Newmann and Associates (1996) through a five year, federally funded study, provided valuable insight to conditions under which innovations in a school's organization contribute to achievement. They recommended standards for reaching student intellectual quality and offered evidence of how these standards work.

Authentic learning occurs through tasks, activities, and assessments that result in achievement, which is significant and meaningful, according to Newmann and Wehlage (1993). Newmann and Wehlage (1993) relied on three criteria consistent with proposals to
Wisconsin’s Center on Organization and Restructuring of Schools, namely: (1) students construct meaning and produce knowledge; (2) students use disciplined inquiry to construct meaning; and (3) students aim their work toward production of discourse, products, and performances that have meaning or value beyond success in school.

Driscoll (1994) noted that authentic learning is a constructivist approach to learning based on common assumptions of constructivism: (a) complex, challenging learning environments and authentic tasks; (b) learning through shared responsibility and social negotiation, (c) multiple representations of the content; (d) understanding that knowledge is constructed; and (e) student-centered instructions.

Newmann and Wehlage (1993) found the challenge is not simply to adopt groundbreaking teaching techniques or seek new venues for learning, but to assess the extent to which any given activity, regardless of where it occurs, engages students to use their minds well.

Five standards of authentic instruction were developed to address these concerns (see Figure 1). Newmann and Wehlage (1993) reported that these five standards to estimate levels of authentic instruction were being used in social studies and mathematics in elementary, middle, and high schools. Their purpose was not to evaluate schools or teachers, but to learn how authentic instruction and student achievement are facilitated by restructuring and organization of schools, content of programs, quality of leadership, and the school and community culture.
**Five Standards of Authentic Instruction**

1. Higher-Order Thinking
   
   lower-order thinking only  1...2...3...4...5  higher order thinking is central

2. Depth of Knowledge
   
   knowledge is shallow  1...2...3...4...5  knowledge is deep

3. Connectedness to the World Beyond the Classroom
   
   no connection  1...2...3...4...5  connected

4. Substantive Conversation
   
   no substantive conversation  1...2...3...4...5  high-level substantive conversation

5. Social Support for Student Achievement
   
   negative social support  1...2...3...4...5  positive social support

*Figure 1: Five Standards of Authentic Instruction*

Source: Newmann & Wehlage (1993).
Further, Woolfolk (2001) found authentic tasks have connections to real-life problems and situations students encounter outside the classroom.Ormrod (2000) emphasized that an authentic activity promoted problem solving, critical thinking, synthesized knowledge, and application of skills in real-life contexts.

**Inquiry-based Learning**

Inquiry-based learning or problem-based learning (PBL) and instruction historically have held a prominent role in agricultural education classrooms across the United States, especially in school-based agricultural education (SBAE) (Wells, Matthews, Caudle, Lunceford, & Clement, 2015; Parr & Edwards, 2004). There is a need for SBAE programs to move beyond curricula that emphasizes memorization toward advanced concepts that challenge students and require knowledge in academic subjects (Edwards, 2004). SBAE programs are situated so that teaching and learning strategies emphasize the development of the individual and offer a broader variety of learning experiences that suit a wide spectrum of student interests and learning styles (Phipps et al., 2008; Edwards, 2004) (see Table 1).

According to Merriam-Webster, *inquiry* is a request for information; the act of asking questions in order to gather or collection information; or an official effort to collect and examine information about something (Merriam-Webster, Inc., 2015). Whether the word is spelled using the American *I* or the English *E*, the meaning is the same, inquiry based on question(s) asked by a learner or investigator. However, the field of science education has its own concept of the meaning of the word (Martin-Hauser, 2002; Minstrell & van Zee, 2000).
Table 1. Typical Student Inquiry-Based Classrooms

<table>
<thead>
<tr>
<th>Traditional Approach</th>
<th>Inquiry-based Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listen-to-learn method of learning</td>
<td>Learning is question-oriented with real and authentic goals</td>
</tr>
<tr>
<td>Little interaction, individual work</td>
<td>Peer interaction, team work</td>
</tr>
<tr>
<td>Assessments in the form of tests and term papers</td>
<td>Shared end product with an audience</td>
</tr>
<tr>
<td>Limited knowledge imparted by the teacher</td>
<td>Ability to dig deeper into a topic</td>
</tr>
<tr>
<td>Mastery of content</td>
<td>Development of skills and questioning along with mastery of content</td>
</tr>
<tr>
<td>Receivers of information</td>
<td>Pursuers of information</td>
</tr>
<tr>
<td>Mastery of content</td>
<td>Development of habits of the mind</td>
</tr>
<tr>
<td>Students are passive recipients of knowledge</td>
<td>Students are actively involved in learning and construction of knowledge</td>
</tr>
<tr>
<td>Moderate to low interest</td>
<td>High interest</td>
</tr>
<tr>
<td>Textbook dictated learning</td>
<td>Student focused learning</td>
</tr>
<tr>
<td>Evaluation at the end</td>
<td>Ongoing assessment</td>
</tr>
</tbody>
</table>

Source:
http://courseweb.lis.illinois.edu/~dafagan2/LIS506LEB/best_practices/traditional_vs_IL
Inquiry has been viewed as a teaching strategy and a set of student skills, such as individual process skills (Barman, 2002). Another study found alternative definitions of inquiry: habit of mind (encouraging inquisitiveness), teaching strategies for motivating learning, and hands-on and minds-in, manipulating materials to study particular phenomena, and stimulating questions from students (Martin-Hauser, 2002; Minstrell & van Zee, 2000).

Minstrell (2000, pg. 473) found an inquiry was complete when something that was not previously known is known. When research fails to find an answer, the inquiry, or more simply the question, should yield a greater understanding of factors involved in finding the solution. Students nurtured to seek information will continue to do so even when a class is done for the day (Newcomb & Trefz, 1987).

A former science teacher, John Dewey, recommended the inclusion of inquiry into K-12 science curriculums (Dewey, 1910). Dewey noted that the educational establishment of his day was unwilling to embrace the incorporation of science into their educational system. In part, this unwillingness may have resulted from the rigid scientific methods, which consisted of six steps: sensing perplexing problems, clarifying the problem, formulating a tentative hypothesis, testing the hypothesis, revising with rigorous testing, and acting on the solution (Dewey, 1910). Dewey encouraged K-12 science teachers to use inquiry as a teaching strategy where the student is actively involved, and the teacher is a facilitator and guide. Students should be encouraged to address problems they want to know and apply it to the observable phenomena (Dewey, 1916).

Dewey modified the earlier scientific goal of relative thinking: presentation of the problem, formation of a hypothesis, collecting data during the experiment, and formulating a conclusion. Problems must be related to the students’ experiences and within their
intellectual capacity; for the students need to be active learners in searching for answers, Dewey noted (Dewey, 1938).

In 1960, Joseph Schwab described two types of inquiry: stable (growing body of knowledge) and fluid (invention of new conceptual structures that revolutionize science) (Schwab, 1960). Schwab (1960) encouraged teachers to use laboratories to aid students in their study of scientific concepts. He recommended science be taught using an inquiry format.

**Project Synthesis.**

Project Synthesis, a compilation of three major National Science Foundation (NSF) projects, found the greatest emphasis was placed on academic preparation (Harms & Yager, 1981). Inquiry was one of the five areas of Project Synthesis and was approached from two dimensions: teachers and students, and strategy used to help students learn science (Welch, Klopfer, Aikenhead, & Robinson, 1981). Welch et al. (1981) found teachers do not use inquiry and identified the following reasons: limited teacher preparation, including management; lack of time, limited materials available; lack of support; emphasis on content only; and difficult to teach. Later research identified three main reasons for avoidance of inquiry: state documents emphasizing content, easier to access content, and textbooks’ emphasis of science as a body of knowledge (Eltinge & Roberts, 1993).

**Project 2061.**

Project 2061, a long-term effort of the American Association for the Advancement of Science (AAAS) to reform K-12th grade science, identified what all students should know and be able to do when they graduate the 12th grade (American Association for the Advancement of Science, 2016). *Science for All Americans (SFAA)*, their first document,
broadly defined scientific literacy (Rutherford & Ahlgren, 1989). *Benchmarks for Scientific Literacy* organized the topics into K-2, 3-4, 5-8, and 9-12 grade groupings (American Association for the Advancement of Science, 1993). Project 2061 established goals for teaching inquiry in SFAA chapter titled, “Habits of the Mind”: start with questions about nature, actively engage students, concentrate on collection and use of evidence, provide historical perspective, insist on clear expression, use a team approach, do not separate knowledge from finding out, de-emphasize memorization of technical vocabulary.

Science educators have multiple interpretations of inquiry. This has led to confusion between educators, students and parents. The National Research Council (NRC) released *Inquiry and the National Science Education Standards* to clarify what inquiry means (National Research Council, 2000). Simply put, every inquiry must engage the students in a scientifically oriented question of interest to the student; otherwise, students will not be engaged.

The National Science Education Standards (NRC, 1996) recommended professional development programs for K-12 teachers of science need to model inquiry in the offerings. Sessions should provide participants the opportunity to become comfortable with experiencing inquiry before implementing inquiry in the classroom. Further, model inquiry units and lessons should be demonstrated along with classroom visitations, videos, and vignettes with discussion afterwards. Consultative assistance should be available teachers implementing inquiry lessons (National Research Council, 1996).

Calls for increased student achievement have led to innovative and challenging teaching and learning methods within all classrooms (Pearson, et al., 2010; Stone III, Alfeld, & Pearson, 2008). Teaching methods should learning through hands-on applications that
reinforce academic content and aid students’ natural inclinations and abilities to learn useful content (Phipps, Osborne, Dyer, & Ball, 2008; Stone, et al., 2008).

**Experiential Learning**

Experiential learning can be defined as “a philosophy and methodology in which educators purposefully engage with students in direct experience and focused reflection in order to increase knowledge, develop skills, and clarify values” (Association for Experiential Education, 2016, para. 2). Often referred to as “learning through doing”, experiential learning can be defined by the following maxims:

*I hear and I forget, I see and I remember, I do and I understand.

Confucius, 450 BC

Tell me and I forget, Teach me and I remember, Involve me and I will learn.

Benjamin Franklin, 1750

There is an intimate and necessary relation between the process of actual experience and education. All learning is experiential, but all experiences are not educational.

John Dewey, 1938

The groundwork for “learning through doing” theories were provided through educational psychologists such as John Dewey (1859-1952), Carl Rogers (1902-1987), and David Kolb (b. 1939). While each made significant contributions to understanding experiential learning, the key element remains the student, and the knowledge gained (learned) as a result of personally being involved in the process.

“Learning is the process whereby knowledge is created through the transformation of experience” (Kolb, 1984, p. 38). Kolb represented this process in the four stage learning cycle in which a learner “touches all the bases” (see Figure 2).
Experiential education is typically associated with secondary and post secondary education, not elementary education. However, the following research suggests otherwise.

Legend says that King Alfred planted school gardens so boys could have agricultural training, and is mentioned as the beginning of Oxford University (Dadisman, 1921, p.16). Dadisman (1921) noted that gardens were used as an instructional tool throughout Europe. He also noted that in 1564 the Jesuits that argued that learning should be related to living things and that materials for education are not always found in books, but from the external world, including the usual occupations of men (Dadisman, 1921, p. 16).

Faced with a growing concern for childhood obesity, certain cancers, and other chronic diseases, the use of school gardens as a learning approach to enhance nutritional education to students is gaining ground considering fewer than half of boys and girls age 4-18 years old consume more than 5 servings of fruits and vegetables on a daily basis (American Institute for Cancer Research, 2007; Guenther, Dodd, Reedy, & Krebs-Smith, 2006; Van Duyn & Pivonka, 2000).

Parmer, et al. (2009) found that second grade students who received nutrition education instruction and participated in the school garden scored significantly higher in their nutrition knowledge, fruit and vegetable preference, and vegetable choice and consumption than students who received nutrition education instruction only or the control group. Another garden-based nutrition education study with sixth grade students indicated a significant increase in the consumption of fruits and vegetables by the treatment group after participating in the study (McAleese & Rankin, 2007).

In a review of the impact of garden-based nutrition intervention programs examining peer-reviewed studies conducted between 1990 and 2007, researchers found five studies
Figure 2: Kolb's Learning Cycle Experiential Learning

Source: http://www.simplypsychology.org/learning-kolb.html
took place on school grounds and were integrated into the school curriculum, three studies were conducted as an afterschool program, and three additional studies were conducted within the community (Robinson-O'Brien, Story, & Heim, 2009).

In a Temple, Texas study, third, fourth and fifth grade students participated in a school gardening program which resulted in significantly higher science achievement scores than the control group (Klemmer, Waliczek, & Zajicek, 2015).

According to Knobloch (2003), agricultural educators should based their instruction on an experiential model that is grounded on the four tenets of experiential learning in agricultural education: learning through doing (Dewey, 1938); learning by doing (Knapp, cited in Lever, 1952); learning through projects (Stimson, 1919); and learning through solving problems (Lancelot, 1944), stating that these are aligned with Newmann and Associates authentic learning standards and more likely to provide a sound framework for learning.

As these studies suggest, experiential learning helps students broaden and enrich their educational experience through a solid foundation of learning.

**Frameworks in Agricultural Literacy Education**

To address the need for educating an “agriculturally literate” populace, Nunnery (1996) noted that building of a literacy framework for understanding agriculture’s viewpoint and perspective was necessary. In 1994, Leising and Zilbert addressed agricultural literacy similarly and developed a systematic curriculum framework identifying what students should know or should be able to do. In the initial framework, 39 panelists along with more than 160 specialists in eight agricultural related groups were involved to validate the Food and Fibers Systems Literacy Framework (FFSL), which determined and explained what an
agriculturally literate student should understand (Leising & Zilbert, Validation of the California agriculture literacy framework, 1994). The FFSL, composed of a series of standards in five thematic areas, demarcated the components necessary for understanding how the food and fiber systems related to daily life. The standards, broken down into grade-grouped benchmarks (K-1, 2-3, 4-5, 6-8, 9-12), provided the FFSL with a well-organized means of addressing agricultural literacy in the context about agriculture.

Igo, Leising and Frick (1999) addressed student literacy through program assessment focused on K-8th grade teachers and students in elementary and middle schools located in Montana and Oklahoma. Instruments used for measuring student knowledge were based on the FFSL Framework for themes and standards at the grade-level benchmarks. At the time of this study, revisions to the FFSL had been undertaken, but not nationally disseminated (University of Minnesota, 2012). Therefore, this is currently the only instrument for assessing agricultural knowledge.

At the time of this writing, there are two agricultural literacy frameworks: Food and Fiber Systems Literacy Framework (Igo, Leising, Frick, Hubert, & Malcolm, 1999), and Project Food, Land and People (http://www.foodlandpeople.org).

**Food and Fiber Systems Literacy Framework (FFSL)**

The Food and Fiber Systems Literacy Framework is composed of a series of standards in five thematic areas, each delineates the components necessary for understanding how the food and fiber systems relates to daily life. The standards are broken down into grade-grouped benchmarks (K-1, 2-3, 4-5, 6-8, 9-12). The standards and benchmarks are designed to infuse food and fiber systems, or agricultural education, into core academic subjects through existing connections through classroom learning activities.
(Igo, et. al, 1999) (See Appendix C-Food and Fiber Literacy Framework-Themes and Standards and Appendix D-Food and Fiber Systems Literacy Framework-Standards and Benchmarks). This Framework has been used by teachers, state agricultural education leaders, directors of curriculum and others in over 30 states since 1998 (University of Minnesota, 2012).

In 2010, the National Institute of Food and Agriculture (NIFA) sponsored Grant Number 2010-38858-21831 (Proposal Number 2010-04609) to revise and reinvent the FFSL Framework. The project had two phases: Phase I-Develop a National Ag in the Classroom Curriculum Advisory Committee composed of two state contacts from each region of the U. S.; and to review current FFSL and advise project director, Dr. James G. Leising, of essential elements of a new Agricultural Literacy Map. Phase II-Developed the Agricultural Literacy Map of major activities, assemble content experts to review themes and benchmarks of existing FFSL to determine importance, relevancy, and supplication, and identify new content for inclusion; to cross-reference of Map to Common Core State Standards; and to develop field testing and dissemination strategies. The AITC Advisory Committee recommended that a project, connecting lesson plans to the Agricultural Literacy map be conducted prior to field-testing of the Map. However, the field-testing strategy was not addressed (University of Minnesota, 2012).

**Project Food, Land & People, Inc. (FLP)**

The Project Food, Land and People is a conceptual framework of six comprehensive ideas from agricultural awareness to responsible food, land, and people decision-making for today and the future. The framework is further divided into subdivisions, which identifies
topics and concepts used by teachers and educators to create instructional lessons (Project Food, Land & People, 2012).

**Agricultural Literacy Models**

Additionally there are two agricultural literacy models: Pillars of Agricultural Literacy (American Farm Bureau Foundation, 2015) and National Agricultural Literacy Outcomes (National Agricultural Literacy Outcomes, 2014).

**Pillars of Agricultural Literacy**

The American Farm Bureau Foundation for Agriculture has defined an agriculturally literate person as one who “understands the relationships between agriculture and the environment, food, fiber and energy, animals, lifestyle, the economy and technology”. Through its *Pillars of Agricultural Literacy*, the American Farm Bureau Foundation strives to cultivate and build awareness, understanding, and a positive public perception of agricultural literacy in any person, no matter their age or experience (American Farm Bureau Foundation, 2015) ([http://www.agfoundation.org/](http://www.agfoundation.org/)).

**National Agricultural Literacy Curriculum Matrix**

The National Agricultural Literacy Outcomes (NALOs), a synthesis of influential research and the above mentioned agricultural literacy frameworks, resulted in the development of five critical thematic areas focused on the newer agricultural literacy definition, namely, a “person who understands and can communicate the source and value of agriculture as it affects the quality of life” (National Agricultural Literacy Outcomes, 2014) ([http://www.agclassroom.org/teacher/matrix/](http://www.agclassroom.org/teacher/matrix/)).

**Educational Measurement in Agricultural Education**

There are several types of assessments used to measure student learning in
agricultural education. These include, but are not limited to, standards-based assessment, criterion-based assessment, and authentic assessment.

**Standards-Based Assessment**

Standards-based assessments, or norm-referenced assessments, are effective ways to measure student learning. Assessments give educators a variety of strategies for assessing whether students are meeting local, state, and national content standards. In this age of accountability, assessments have become a valuable resource for augmenting and documenting student learning (Lambert, 2007).

In the last 20-30 years, assessment has become one of the newest “buzz” words in education. During this time, mountains of printed materials, hundreds of conferences, iterations of federal and state policies, and school-based reform initiatives have been generated, all in the name of assessment (Lambert, 2007, p. 1). Wilson observed in *Consilience: The Unity of Knowledge* (1998), “We are drowning in information while starving for wisdom” (Wilson, 1998, p. 269).

Lambert (2007) found that to design effective programs, professional dialogue and respected research designs need to drive “best practices” through careful thought and clear conceptual wisdom. These programs should not occur haphazardly, but require uncompromised commitment to student learning to refine the practices. A thoughtful, organized plan for teaching from concept introduction to student demonstration of learning will form a firm foundation (Lambert, 2007).

Effective program design must include curriculum, instruction, and assignment design components. Assessment with curriculum and instruction must result in an effective tripartite whole. Theoretical and conceptual criterions provide practical framework to
establish processes for planning and implementing standards-based assessment (Lambert, 2007).

Lambert (2007) found that assessment models could vary considerably from adherents to a particular policy requirement to conformists to normative assessment practices and dominant standards of educational research. However, this does not lead to educating students to learn the things that matter most, but pursues “results” thus, missing the point of individual learning. Assessment is a two-edged sword. If the policy path is chosen disregarding its affects toward learning, the initiatives are disappointing. If the need for assessment models from the standpoint of learning is chosen, the models are likely to follow those of the past (Worthen, 1993).

One of the most disturbing problems found in Pre-K-12th grades is the widening gap between assessment theory and practice (Nettles, 1995). Nettles (1995) found that standards-based assessment practices often used a “mix and match” approach. This has created a tug-of-war between conceptual and theoretical practices, yet it is the fundamental duty of professional educators to strike a balance between the quality of the programs and the demand for accountability (Lambert, 2007, p. 5).

Education is about power. Lambert (2007, p. 5) noted that assessment of student learning is a three-prong power play: power of a teacher to influence student learning, personal power a student gains through the acquisition of knowledge, and power of persuasion and influence a teacher’s pedagogical options have in crafting the voyage of learning and the liberty learning provides.

If the history of assessment has taught the educational system anything, it appears that excessive emphasis is placed on standardized testing rather than student learning.
Currently, limited time exists in an educator’s instructional day to focus on any more than “teaching to the test” ensuring students can “test well” (Lambert, 2007, p. 10).

**Criterion-Based Assessment**

Criterion-based assessment is designed to measure a student’s performance based on mastery of a specific set of skills at the time of assessment. A good example is a driving test. Whereas, norm-referenced assessment measures a student’s performance in comparison to other same age students taking the same assessment and is scoring is based on a bell curve, meaning only half of those tested scored above the 50th percentile. An example is the SAT, which compares the abilities of one high school student to another.

Assessments based on student performance can be used to provide feedback and inform future teaching and learning needs (Green, 2002).

**Authentic Assessment**

Assessment can be considered authentic when student performances on worthy intellectual tasks are examined. By contrast, traditional assessment relies on indirect or proxy “items” or simplistic substitutes from which potentially valid inferences can be concluded about a student’s performance based on the challenges of the particular assessment (Wiggins, 1990).

Wiggins (1990) found authentic assessments required students to be effective performers with acquired knowledge. Traditional assessment tends to show whether the student can recall what was learned or “regurgitate” the learning.

Authentic assessments present students with a full array of tasks that mirror real-life situations rather than being limited to paper and pencil or one-answer questions. They also
allow students to demonstrate justifiable answers or performances that conventional testing only allows a student to write or select correct responses (Wiggins, 1990).

Wiggins (1990) noted that authentic assessment achieves validity and reliability by emphasizing and standardizing appropriate criteria for scoring in contrast to traditional testing’s “one” right answer approach.

Authentic assessment provides parents and community members with understandable evidence concerning students’ performance and is more discernible to laypersons. Wiggins (1990) noted that as researcher, Lauren Resnik said, “What you assess is what you get; if you don’t test it, you won’t get it”.

Summary

This review of literature in this chapter has provided contextual information regarding agricultural literacy in the United States and globally: it’s origins, developments, and current status. The review has examined definitions of agricultural literacy from conceptual to the currently accepted definition, agricultural literacy programs in the United States and globally, research in agricultural literacy, educational and learning standards, frameworks and literacy models for the development and assessment of agricultural literacy, and educational measurement in agricultural education.

Additionally, the review of literature did not reveal any statewide studies utilizing the FFSL Framework and criterion-referenced instruments to determine the agricultural literacy of Illinois elementary students. As a result, it was determined that research was needed to access the agricultural knowledge of Illinois elementary school students; to understand their level of agricultural literacy, and to determine strengths and weaknesses of
agricultural knowledge for this group of students using the five thematic areas of food and fiber identified in the FFSL Framework.
CHAPTER 3

METHODOLOGY

Introduction

Agricultural literacy is a field that is extremely important and has far-reaching implications and consequences beyond the agricultural sector. However, agricultural literacy is an area often unseen and rarely discussed outside specific agricultural disciplines (Doerfert, 2011). Kovar and Ball (2013) found an agriculturally literate individual would make sound decisions regarding agricultural policy, production agriculture, and accurately disseminate information pertaining to other pressing issues related to agriculture. The non-agricultural population has little to no understanding or comprehension of the complexities involved in sustaining a viable agricultural system and is agriculturally illiterate due to urbanization and the advancement of technologies in agriculture (Doerfert, 2011; Leising et al., 2000).

Purpose of the Study

The purpose of this study was to assess the agricultural knowledge of selected Illinois classrooms of public elementary school students in kindergarten through fifth grades, and determine if gaps exist in the current elementary educational curriculum regarding instructional topics that would lead to agricultural literacy. To accomplish this, this study utilized instruments based on the Food and Fiber Systems Literacy Framework standards and benchmarks for data collected on the agricultural knowledge of Illinois public elementary school students. The methods and procedures used in developing and conducting this research study are described in this chapter.
Objectives of the Study

The study aimed to assess the agricultural knowledge of selected Illinois classrooms of public elementary school students in kindergarten through fifth grades that employ Agriculture in the Classroom (AITC) methods and materials. The specific research objectives were:

1. Develop a demographic profile of schools that participated in the study.
2. Assess differences using sum score means between AITC treatment group and control group in student knowledge about agriculture, before and after AITC instruction, for each grade grouping (K-1, 2-3, 4-5).
3. Assess differences in sum score means between AITC treatment groups and control groups in student knowledge about agriculture, before and after AITC instruction, using the five thematic areas of the Food and Fiber Systems Literacy (FSSL) Framework between schools for each grade grouping (K-1, 2-3, 4-5).
4. Assess theme score mean gains between treatment and control groups in student knowledge about agriculture, before and after AITC instruction, for each grade grouping (K-1, 2-3, 4-5).
5. Develop a profile of student knowledge about agriculture, before and after AITC instruction based on pre- and posttest mean scores, for each grade grouping (K-1, 2-3, 4-5) by the five thematic areas of the Food and Fibers Literacy (FSSL) Framework.
6. Develop a demographic profile of students that participated in this study.
**Institutional Approval-Human Subject Committee (HSC)**

Federal regulations and Southern Illinois University Carbondale policy require review and approval of all research studies that involve human subjects before investigators can conduct their research. The Southern Illinois University Carbondale Office of Sponsored Projects Administration (OPSA), through the Human Subject Committee (HSC), reviews all research involving human subjects. In compliance with the aforementioned policy, this study received proper review and was granted permission to proceed. The Human Subjects Committee assigned the protocol number 15281 (See Appendix A-Human Subjects Committee Approval Notification). Written administrative consent from each principal for each school site was required by the HSC, and an appropriate form was developed to meet this requirement (See Appendix B-Administrative Consent Form).

**Research Design**

This study utilized a quasi-experimental nonequivalent control group, using a pretest and a posttest, as described by Cook and Campbell (1979). Quasi-experimental designs are used where non-randomization of treatment groups are allowed (Ary, Jacobs, & Sorenson, 2010). Some suggest pretests may influence results (Blakstad, 2008). However, this is one of the more frequently used designs in social sciences to measure the degree of change occurring as a result of a treatment or intervention (Shuttleworth, 2009). Cook and Campbell (1979) noted while not a true experimental design by name, quasi-experimental designs could sometimes provide a more natural, generalizable environment that better establishes effectiveness (as opposed to efficacy, typically associated with medical research).
Treatment and control groups were selected in each participating FCAE District within Illinois. The treatment group was comprised of classrooms (K-5) in schools that utilize AITC Literacy Coordinators, training, and/or materials in the academic year 2015-2016. The control group was comprised of classrooms (K-5) in schools that did not utilize AITC Literacy Coordinators, training, and/or materials in the academic year 2015-2016. The control groups were selected from schools that were similar in size and geographic location to the treatment groups. A pretest and posttest were administered to students to measure their knowledge about agriculture.

**Population**

The population of this study included a cross-section of selected public elementary school classrooms across the state of Illinois during the 2015-2016 academic school year. As random sampling was not feasible based on unique characteristics of each school and the availability of subjects in intact groups, this study employed a purposive sample (Lund Research Ltd., 2012; Wiersma, 1995).

One form of purposive sampling technique, or homogeneous sampling, contains units, which are similar in terms of age and background (Black, 2010). Worthen, Sanders and Fitzpatrick (1997, p. 359) employ the term “judgment sampling”, the strength of which is found in describing a subgroup, which permits a better understanding of the program as a whole. This non-probability sampling approach is based on particular characteristics or judgments, which will best enable the research questions to be answered; these are specific to the characteristics of a particular group and is not to be considered a weakness (Explorable, 2016; Lund Research Ltd., 2012). In this study, the researcher selected the schools based on the knowledge and professional judgment of the Illinois County AITC
Literacy Coordinators who participated, and not based solely on the researcher’s knowledge or judgment.

Illinois is a very vertical state (north/south), 390 miles long and 210 miles wide. While the state’s 57,918 square miles ranks 25\textsuperscript{th} in land size, it’s over 12 million residents places it fifth in terms of total population.

To obtain a cross-section of a diverse population, the purposive sample included public elementary school classrooms located in counties within the five Facilitating Coordination in Ag Education (FCAE) districts (see Figure 3).

The counties were selected randomly from each FCAE District, which consisted of 87 counties (see Table 2). The Agricultural Literacy Coordinators for each selected county, within each FCAE District, were contacted regarding participation in the study. The participating County Agricultural Literacy Coordinator identified four or more public elementary schools (K-5\textsuperscript{th} grades): two or more public elementary schools identified incorporated the Agriculture in the Classroom (AITC) instructional program, training and/or use of AITC related materials for the academic school year 2015-2016, and two or more public elementary schools had no exposure to or did not use the AITC instructional program, training and/or use of AITC related materials for the academic school year 2015-2016 (see Table 3).

The target population was 500 students, similar in number per state, to the original study conducted by Leising, et al. in 2003. The population included students in schools whose student population varied from 81 to 148 students. Intact groups of students reflected diverse academic ability, both genders, and all present ethnicities were included in the
Figure 3: Facilitating Coordination in Agricultural Education Districts

Source: Illinois Association of Vocational Agriculture Teachers (2016)
Table 2. *Facilitating Coordination in Agricultural Education (FCAE) Districts by Counties*

<table>
<thead>
<tr>
<th>FCAE District</th>
<th>Counties Within District</th>
<th>Number of Counties</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Cook, DeKalb, DuPage, Grundy, Kane, Kankakee, Kendall, Lake, LaSalle, Marshall, Mason, Menard, McHenry, Putman, Whiteside, Will</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>Fulton, Greene, Hancock, Jersey, Logan, Macoupin, Madison, McDonough, Pike, Sangamon, Schuyler, Scott</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>Coles, Crawford, DeWitt, Douglas, Edgar, Effingham, Fayette, Ford, Iroquois, Jasper, Macon, Montgomery, Moultrie, Piatt, Shelby, Vermillion</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>Alexander, Franklin, Gallatin, Hamilton, Hardin, Jackson, Jefferson, Johnson, Marion, Massac, Monroe, Perry, Pope, Pulaski, Randolph, Richland, Saline, St. Clair, Union, Wabash, Washington, Wayne, Williamson</td>
<td>23</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>87</strong></td>
</tr>
</tbody>
</table>

Source: Illinois Agriculture in the Classroom, County Coordinator List, 2015.
**Table 3. Potential Counties and Schools Identified by FCAE Districts**

<table>
<thead>
<tr>
<th>FCAE District</th>
<th>Potential Counties Identified</th>
<th>Number of Potential Schools Identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>McLean</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Cook, McLean, DeKalb</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Carthage</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Fayette</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Franklin, Jackson, Union, Williamson</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>31</td>
</tr>
</tbody>
</table>
population. The final population was 430 students rather than the targeted population of 500 students (see Table 4).

To obtain an adequate cross-section of students, different strategies were utilized according to organizational differences at each school. School district reorganization in Illinois began in the mid-1990s as a method of consolidating resources and personnel (Hall & Arnold, 1993). Some school districts did not implement the program until the beginning of the 2013-2014 academic school year due to the need for established infrastructure to house the incoming students. Other districts were in transition at time of the writing of this study per conversations with local area teachers. This school district reorganization resulted in some districts transitioning to attendance centers, which only included K-2nd grades or 3rd-5th grades.

Therefore, additional schools were selected to compensate for this change and to adequately reflect the agricultural knowledge of K-5th grade students in Illinois following the initial selection guidelines.

In early September 2015, the researcher contacted all Illinois County Agricultural Literacy Coordinators in all five FCAE Districts to identify treatment and control schools in their respective areas for potential participation this study. Responses were received throughout the month.

In early October 2015, the identified schools received a letter of introduction to the researcher and the research study, an administrator’s permission form, a parental consent form (HSC requirement), a student consent form (HSC requirement), and a sample of the testing instruments. A follow-up email and phone call followed approximately one week later to confirm participation. If the identified potential school failed to respond, or denied
Table 4. *Summary of Schools and Students Composing the Study Population by FCAE Districts*

**Pretest**

<table>
<thead>
<tr>
<th>FCAE District</th>
<th>County</th>
<th>School</th>
<th>K</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>Total Students Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>2</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
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<td>*</td>
<td>*</td>
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<td>*</td>
<td>*</td>
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<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>4</td>
<td>Fayette</td>
<td>1</td>
<td>21</td>
<td>27</td>
<td>23</td>
<td>31</td>
<td>20</td>
<td>26</td>
<td>148</td>
</tr>
<tr>
<td>5</td>
<td>Union</td>
<td>1</td>
<td>11</td>
<td>14</td>
<td>13</td>
<td>11</td>
<td>16</td>
<td>16</td>
<td>81</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>2</td>
<td>32</td>
<td>41</td>
<td>36</td>
<td>42</td>
<td>42</td>
<td>229</td>
</tr>
</tbody>
</table>

* Denotes districts with no participating school

**Posttest**

<table>
<thead>
<tr>
<th>FCAE District</th>
<th>County</th>
<th>School</th>
<th>K</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>Total Students Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>2</td>
<td>DeKalb</td>
<td>1</td>
<td>17</td>
<td>17</td>
<td>16</td>
<td>16</td>
<td>22</td>
<td>22</td>
<td>110</td>
</tr>
<tr>
<td>3</td>
<td>Carthage</td>
<td>1</td>
<td>10</td>
<td>13</td>
<td>14</td>
<td>25</td>
<td>14</td>
<td>15</td>
<td>91</td>
</tr>
<tr>
<td>4</td>
<td>Fayette</td>
<td>1</td>
<td>21</td>
<td>27</td>
<td>23</td>
<td>**</td>
<td>20</td>
<td>26</td>
<td>125</td>
</tr>
<tr>
<td>5</td>
<td>Union</td>
<td>1</td>
<td>10</td>
<td>14</td>
<td>13</td>
<td>11</td>
<td>16</td>
<td>16</td>
<td>80</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>4</td>
<td>58</td>
<td>71</td>
<td>43</td>
<td>83</td>
<td>72</td>
<td>79</td>
</tr>
</tbody>
</table>

* Denotes districts with no participating school

**Denotes school failed to return posttests**
permission to conduct the study, the researcher contacted the local County Agricultural Literacy Coordinator for additional potential schools. If additional potential schools failed to respond or denied permission to conduct the study, the researcher continued the study with the participating schools.

Pretest instruments, separated by grade levels, including testing instructions to the teachers along with direct contact information for the researcher, were sent to the participating schools by late October to mid November 2015. All pretests were completed and returned to the researcher by early to mid December 2015. Posttest instruments, separated by grade levels, including testing instructions to the teachers along with direct contact information for the researcher, were sent to the participating schools in late March to early April. All posttests were completed and returned to the researcher by late April to mid May 2016. Testing time varied with each grade level from 30 minutes to 40 minutes and were conducted in a single classroom period, rather than spread the testing out over several days as allowed by the instructions to the teachers.

Four schools, identified by the Agricultural Literacy Coordinator in FCAE District 1, granted permission through their Regional Office to conduct this research study. However, when the researcher contacted the school principals to determine number of classrooms and student population, the Regional Office revoked permission, stating the study was going to require “too much time” for testing (see Limitations, Chapter 1).

One school identified in FCAE District 2, also granted permission for the study. Again, when requesting the number of classrooms and student population, the researcher was told the principal, who initially granted permission, was out on medical leave. The interim principal revoked permission without offering a reason.
One school identified in FCAE District 4 was removed from the study, as it was the only parochial school willing to participate in the study.

Two schools identified in FCAE District 5 were removed from the study, as the schools initially were identified as control schools, but had received AITC instruction in at least one of their grade levels and classrooms.

**Instrumentation**

A review of the literature indicated previous studies utilized a variety of data collection instruments. Some researchers elected to create a new instrument to achieve research objectives (Doerfert D., 2003). Other researchers developed an instrument based on the 11 agricultural literacy objectives identified by Frick, et al. (Frick, Kahler, & Miller, 1990). Doerfert (2003) noted that a select number of researchers chose to utilize instruments developed by another researcher(s).

The researcher chose to utilize the original instruments, developed and tested by Leising and Igo, based on the K-5th grade benchmarks of the FFSL Framework of standards and benchmarks for agricultural literacy (Leising, Igo, Heald, Hubert, & Yamamoto, 1998)(see Appendix D). At the time of this study, no other instrument had been developed, tested, or was available to assess agricultural literacy knowledge of students in K-5.

**Reliability of Testing Instruments**

Reliability of testing instruments can be determined by utilizing Cronbach Alpha or Kuder-Richardson 20 (KR 20). However, Wiersma & Jurs (1990) found these methods are appropriate only for norm-referenced tests or standardized tests, which are designed to measure the differences between individuals by spreading out the scores on a “bell curve”. The test questions are designed to accentuate the performance differences among the test
takers, not to determine if students achieved specified learning standards, learned certain materials, or acquired specific skills or knowledge (Abbott, 2014).

Abbott (2014) noted tests that measure performance against a fixed set of criteria or standards are called criterion-referenced tests. These tests are based on the number of correct answers provided by students with scores expressed as a percentage of the total possible number of correct answers. Common Core State Standards are criterion-referenced exams that along with the federal policy, *No Child Left Behind*, are intended to measure school performance (Abbott, 2014). TerraNova Common Core is an avenue for teachers to “benchmark” learning progress and determine if students are on track to perform well on Common Core-based assessments, which Illinois adopted in 2010, and implemented in 2013-2014 academic year (Abbott, 2014; Illinois State Board of Education, 2016).

The instruments used in this study were criterion-referenced with five thematic areas focused on agriculture, less homogenous, and were previously piloted tested with groups of students not included in the initial study (Leising, Pense, & Portillo, 2003). Leising, et al. (2003) determined the internal consistency using Guttman’s Split-Halves reliability coefficients, to be 0.7763 for kindergarten through first grade, 0.9469 for second through third grade, and 0.7892 for fourth through fifth grade.

**Data Collection**

In order to obtain the broadest cross-section of elementary public school students in Illinois, classroom test sites were purposively selected from the five FCAE Districts by randomly selected county Agriculture Literacy Coordinators and roughly represented by the FCAE Districts. One to six schools in each district were selected for this study resulting in a total of 31 potential study sites.
The instrument, for each appropriate grade, (See Appendix E-Food and Fibers Systems Literacy Tests) was administered at each site by the researcher, County Agricultural Literacy Coordinator, or the teacher. Teachers were instructed to offer assistance as needed in the opinion of the tester. This included reading aloud the testing instrument to younger students. The term, “food and fiber systems,” was allowed to be changed to “farming”. The teachers and Agriculture Literacy Coordinators were informed as to the numbering system for the testing instruments. To ensure anonymity, each instrument was given a six-digit number in an effort to separate test scores, FCAE Districts, school identities, grade levels, as well as the identities of individual students.

Demographic information of each school was based on documents the schools submitted for state and federal funding as well as qualitative observations of the researcher or AITC Agriculture Literacy Coordinators.

Data Analysis

Each student was assigned a six-digit code number that was pre-stamped by the researcher on each grade appropriate instrument. The first digit represented the test, i.e. pretest or posttest. The second digit represented one of the five FCAE Districts. The third digit represented the assigned school number. The fourth digit represented the assigned grade level, Kindergarten to 5th grade. The last two digits represented the student. The identities of the students were not connected to the student numbers on the instruments, but were used to ensure that each student was scored separately and participated in both pretest and posttest, and was grouped according to grade level and school.

Upon completion and retrieval of the pretest instruments, tests were scored by hand and coded into a Microsoft Excel spreadsheet (Microsoft Excel for Mac 2011, Version
14.6.0) for analysis purposes. A data file was created for import to JMP Pro Version 13.0.0 and was used to perform all statistical procedures and analysis of pretest and posttest group data in conjunction with the stated purpose and objectives of this study.

Qualitative methods were used to gather and report demographic information regarding the schools included in this study. School documents and qualitative observations of the researcher or AITC Agriculture Literacy Coordinators provided important data about each site.

Descriptive statistics were utilized to report demographic characteristics of the respondent students. The JMP Pro Version 13.0.0 were used to calculate frequencies and percentages of study respondents by age, gender, and grade. Descriptive statistics were also utilized to describe and summarize observations, specifically; percentages, means, and standard deviations.

Due to the stated potential limitations of this study (see Limitations, Chapter 1), i.e. school administrators failed to respond to the requests of the researcher; school administrators revoked previously granted permission to conduct the research study; school administration changes; and/or stringent review policies regarding outside research studies, the researcher found it necessary to alter the original design of the study. This changed resulted in the implementation of the Solomon Four-Group Design.

**Statistical Treatment Using Solomon Four-Group Design**

Over 65 years ago, Solomon introduced a new form of experimental design referred to as the Solomon four-group design (Solomon, 1949). Campbell and Stanley described the Solomon four-group design (Campbell & Stanley, 1963) as a one-treatment experimental design. They found that the pre- and posttest control group designs and the posttest-only
control group designs were adequate to assess the effect of the treatment and were immune to threats of internal validity. However, the researchers found the Solomon four-group design was the only design able to assess the presence of pretest sensitization or test reactivity (Huck & Chuang, 1977). Huck and Sandler (1973, p.54) noted that “exposure to the pretest increases … the Ss’ sensitivity to the experimental treatment” and prevented generalizations between the pretested group and the unpretested group. Therefore, the Solomon four-group design added a higher degree of external validity in addition to the internal validity leading Helmstadter (1970, p. 110) to conclude it (i.e., the Solomon 4-group design) was the most desirable of all basic experimental designs.

However, the Solomon four-group design is underused. According to Braver and Braver (1988, p. 150), there are four reasons that may contribute to the underuse. First, the assumption that the Solomon four-group design requires twice the number of groups used by the other two designs thus implying that twice the number of subjects is needed. Braver and Braver (1988) found by cutting the size of each group in half, the total sample size retained was comparable to the sample size of the other designs. Further, they found the strategy resulted in adequate statistical power, which was greater than that of the posttest-only control group design.

Second, researchers may have little to no interest in the area of pretest sensitization effects, for which Solomon four-group design has the strongest advantage to detect. Braver and Braver (1988) noted that pretest sensitization is an artifact that could limit the generalizability of the effect for which researcher’s interests are directed or a researcher’s belief that pretest sensitization does not exist in their research area. Additionally, they noted this belief indicates that pretest sensitization artifacts rarely occur, which is supported by
literature reviews (Bracht & Glass, 1968; Lana, 1959; Lana, 1969; Rosnow, 1971; Solomon, 1949). Braver and Braver (1988) stated that the artifact should be considered an effect that could potentially threaten the external validity of a research finding unless the use of the Solomon design has ruled this out.

Third, conclusions may be more complicated using the Solomon design due to the number of comparisons it allows (Oliver & Berger, 1980). This intricacy may dissuade researchers from using Solomon. With increased negativity to allowing outside testing in schools such as the researcher encountered firsthand, if Solomon could demonstrate that a pretest was unnecessary and did not drive the outcome, school administrators may be more amenable to allowing outside testing in their schools or school districts in which only a posttest would be administered.

Fourth, and considered the most important reason by Braver and Braver (1988) is uncertainty concerning the appropriate statistical treatment of Solomon. Braver and Braver that Solomon examines more contingencies and has greater statistical power (i.e., the ability to (1988) agreed with the analysis of Campbell and Stanley (1963) and Huck and Sandler (1973) that Solomon examines more contingencies and has greater statistical power (i.e., the ability to detect significance).

For purposes of this study, the researcher investigated does the possibility of a pretest sensitization, or test reactivity effect, or whether X drives the outcome measure only when a pretest measure is administered. (Campbell & Stanley, 1963). If this were the case, $O_2$ would be higher than $O_4$, but $O_5$ would not be higher than $O_6$ as seen in Table 5. (Braver & Braver, 1988) Evidence indicating pretest sensitization, or test reactivity effect, would be
detected by an interaction. The researcher evaluated a 2 x 2 between-groups analysis of variance (ANOVA) on the four posttests, as indicated in Table 5.

An Analysis of Variance (ANOVA) of the posttest scores of the four participating schools indicated no test reactivity effect was found in this study. Prob > F was reported at 0.91 with a F ratio of 0.24 (see Appendix J). This suggested that the pretest did not drive the posttest, but the treatment drove the posttest. The researcher kept the pretest scores for the purposes of comparing this study to the original study by Leising, Pense and Portillo entitled, “The Impact of Selected Agriculture in the Classroom Teachers on Student Agricultural Literacy” (Leising, Pense, & Portillo, 2001). No meta-analysis data was available for comparison other than originally published results. Additionally, the researcher dropped the pretest scores and examined the posttest only scores for each grade level as opposed to grade groupings.
Table 5. *Three One-Treatment Condition Experimental Design*

<table>
<thead>
<tr>
<th>Design</th>
<th>Group</th>
<th>Pretest</th>
<th>Treatment</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solomon four-group</td>
<td>1</td>
<td>O₁</td>
<td>X</td>
<td>O₂</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>O₃</td>
<td></td>
<td>O₄</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td>X</td>
<td>O₅</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td>O₆</td>
</tr>
<tr>
<td>Pre- and posttest control group</td>
<td>1</td>
<td>O₁</td>
<td>X</td>
<td>O₂</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>O₃</td>
<td></td>
<td>O₄</td>
</tr>
<tr>
<td>Posttest-only control group</td>
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<td>O₅</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td>O₆</td>
</tr>
</tbody>
</table>

Note: O = outcome measure; X = treatment measure

CHAPTER 4

DATA ANALYSIS AND FINDINGS

The objective of this chapter was to present the research findings in graphic and narrative formats. Upon completion of the analysis, the researcher presented the data to address the purpose and objectives of this study.

Introduction

The purpose of this study is to assess the agricultural knowledge of selected Illinois classrooms of public elementary school students in kindergarten through fifth grades, and determine if gaps exist in the current K-12 educational curriculum regarding instructional topics that would lead to agricultural literacy. To accomplish this, the study utilized instruments based on the Food and Fiber Systems Literacy (FFSL) Framework standards and benchmarks for collecting data on the agricultural knowledge of Illinois public elementary school students.

Study Design

A quasi-experimental nonequivalent control group, using a pretest and a posttest, was utilized to study the agricultural knowledge of selected Illinois kindergarten through fifth grade students. A population of 430 students at four schools in four locations was included in the study. Data was collected during the 2015-2016 school year.

The schools, Brownstown Elementary, with 148 students; Lick Creek Elementary School, had 81 students; Nauvoo Elementary School, had 91 students; and Hiawatha Elementary School, with 110 students. Classroom size varied from 11-23 students. The classroom teachers at each site administered the instruments.
Analysis by Study Objectives

Objective 1: Describe the demographic profile of schools that participated in the study.

Descriptions of Research Sites

Qualitative data from documents, observations of Agricultural Literacy Coordinators, and discussion with faculty and administrators helped to develop a demographic profile of each site.

School 1.

Brownstown Elementary School (FCAE District 4) is located in Brownstown, Fayette County, and is situated in the south central part of the state. It is part of the Brownstown Consolidated School District 201. The PK-6 student population totaled 229. The ethnic composition of Brownstown Elementary School students was 95.6% White, 0.9% Black, 2.2% Hispanic, 0.9% Pacific Islander, and 0.4% two or more races. Low-income students comprised 64.6% of the student body and were eligible to receive free or reduced-price lunches, lived in substitute care, or whose families received public aid. Another 3.5% reported being homeless. Additionally, 18.8% of students received special education services. Student mobility rates of 34.6% represented students who transfer in or out of the school between the first school day of October and the last school day of the year, not including graduates. Approximately $5,438 instructional expenditure per pupil was allocated and included only the activities directly dealing with the teaching of students or the interaction between teachers and students. Total revenue was $4.2 million, of which $354,442 was federal funds. The single driving factor in school funding is local property taxes, which yielded $941,292 to the district.
Attendance rate was 96% with an average class size of 17. There was a 15:1 student to teacher ratio at Brownstown Elementary School. The FTE (Full-Time Equivalent) teacher population was 27. The ethnic composition of Brownstown Elementary School teachers was 100% white, of which 81.5% was female and 18.5% was male (Illinois State Board of Education, 2016).

**School 2.**

Lick Creek Elementary School (FCAE District 5) is located in Lick Creek, Union County, and is situated in the far southern part of the state. It is part of the Lick Creek Consolidated School District 16. The PK-8 student population totaled 124. The ethnic composition of Lick Creek Elementary School students was 95.2% White, 1.6% Black, 2.2%, and 3.2% two or more races. Low-income students comprised 37.9% of the student body and were eligible to receive free or reduced-price lunches, lived in substitute care, or whose families received public aid. Another 4.8% reported being homeless. Additionally, 8.1% of students received special education services. Student mobility rates of 5.5% represented students who transfer in or out of the school between the first school day of October and the last school day of the year, not including graduates. Approximately $5,151 instructional expenditure per pupil was allocated and included only the activities directly dealing with the teaching of students or the interaction between teachers and students. Total revenue was $1.1 million, of which $100,380 was federal funds. Local property taxes which yielded $295,983 to the district.

Attendance rate was 95% with an average class size of 12. There was a 12:1 student to teacher ratio at Lick Creek Elementary School. The FTE (Full-Time Equivalent) teacher population was 11. The ethnic composition of Lick Creek Elementary School teachers was
100% white, of which 87.3% was female and 12.7% was male (Illinois State Board of Education, 2016).

**School 3.**

Nauvoo Elementary School (FCAE District 3) is located in Nauvoo, Hancock County, and is situated in the northwestern central part of the state boarding Missouri. It is part of the Nauvoo-Colusa Consolidated School District 325. The PK-8 student population totaled 127. The ethnic composition of Nauvoo Elementary School students was 94.5% White, 1.6% Hispanic, and 3.9% two or more races. Low-income students comprise 63.8% of the student body and were eligible to receive free or reduced-price lunches, live in substitute care, or whose families received public aid. Another 3.1% reported being homeless. Additionally, 17.3% of students received special education services. Student mobility rates were 41.5% representing students who transfer in or out of the school between the first school day of October and the last school day of the year, not including graduates. Approximately $5,309 instructional spending per pupil was allocated and included only the activities directly dealing with the teaching of students or the interaction between teachers and students. Total revenue was $3.2 million, of which $218,552 was federal funds. Local property taxes contributed $2,090,374 to the district.

Attendance rate was 94% with an average class size of 14. There was a 12:1 student to teacher ratio at Nauvoo Elementary School. The FTE (Full Time Equivalent) teacher population was 23. The ethnic composition of Nauvoo Elementary School teachers was 100% white, of which 95.6% was female and 4.4% was male (Illinois State Board of Education, 2016).
Hiawatha Elementary School (FCAE District 2) is located in Kirkland, DeKalb County, and is situated in the far northern part of the state. It is part of the Hiawatha Consolidated School District 426. The PK-8 student population totaled 421. The ethnic composition of Hiawatha Elementary School students was 84.8% White, 0.2% black, 10.7% Hispanic, 0.7% Asian, and 3.6% two or more races. Low-income students comprise 53.2% of the student body and were eligible to receive free or reduced-price lunches, live in substitute care, or whose families received public aid. Another 7.8% reported being homeless with 2.1% demonstrating limited English proficiency. Additionally, 13.3% of students received special education services. Approximately $5,409 instructional spending per pupil was allocated and included only the activities directly dealing with the teaching of students or the interaction between teachers and students. Total revenue was $6.1 million, of which $484,316 was federal funds. Local property taxes added $3,917,616 to the district.

Attendance rate is 95%. Average class size is 20.6 with state average of 21.2. There was an 18.5:1 student to teacher ratio at Hiawatha Elementary School. The FTE (Full Time Equivalent) teacher population was 36. The ethnic composition of Hiawatha Elementary School teachers was 100% white, of which 70.8% was female and 29.2% was male (Illinois State Board of Education, 2016).

Objective 2: Compare differences using sum score means between AITC treatment group and control group in student knowledge about agriculture, before and after AITC instruction, for each grade grouping (K-1, 2-3, 4-5).

Data in Table 6 summarized the AITC treatment and control groups by pretests and posttest mean scores. Data indicated a kindergarten through first grade pretest mean score of
38.66 for the treatment group and 34.54 for the control with standard deviations of 6.87 and 8.16, respectively. Data also indicated a kindergarten through first grade posttest mean score of 39.72 for the treatment group and 38.76 for the control group with standard deviations of 6.72 and 6.66, respectively. Additionally, the differences for the kindergarten through first grade posttest and pretest mean scores were 1.06 for the treatment group and 3.22 for the control group.

Data indicated a second through third grade pretest mean score of 73.89 for the treatment group and 71.96 for the control with standard deviations of 9.93 and 12.84, respectively. Data also indicated a second through third grade posttest mean score of 77.30 for the treatment group and 76.29 for the control group with standard deviations of 10.39 and 9.80 respectively. In addition, the differences for the second through third grade posttest and pretest mean scores were 3.41 for the treatment group and 4.33 for the control group.

Data indicated a fourth through fifth grade pretest mean score of 22.87 for the treatment group and 24.59 for the control with standard deviations of 4.60 and 4.19 respectively. Data also indicated a fourth through fifth grade posttest mean score of 30.70 for the treatment group and 24.34 for the control group with standard deviations of 4.13 and 5.56 respectively. In addition, the differences for the fourth through fifth grade posttest and pretest mean scores were 7.83 for the treatment group and (0.25) for the control group.

Objective 3: Compare differences in sum score means between AITC treatment groups and control groups in student knowledge about agriculture, before and after AITC instruction, using the five thematic areas of the Food and Fiber Systems Literacy (FSSL) Framework between schools for each grade grouping (K-1, 2-3, 4-5). (see Table 7).
Table 6. Summary of Grade Grouping for AITC Treatment and Control Pretest and Posttest Mean Scores

<table>
<thead>
<tr>
<th>Grade Grouping</th>
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<th></th>
<th></th>
<th>Control</th>
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<tr>
<td></td>
<td>n</td>
<td>M</td>
<td>SD</td>
<td>% Correct</td>
<td>n</td>
<td>M</td>
<td>SD</td>
</tr>
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<td></td>
<td></td>
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<tr>
<td>Pretest</td>
<td>47</td>
<td>38.66</td>
<td>6.87</td>
<td>75.80</td>
<td>24</td>
<td>34.54</td>
<td>8.16</td>
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<tr>
<td>Posttest</td>
<td>47</td>
<td>39.72</td>
<td>6.72</td>
<td>77.89</td>
<td>24</td>
<td>38.76</td>
<td>6.66</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>3.22</td>
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</tr>
<tr>
<td>2-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>54</td>
<td>73.89</td>
<td>9.93</td>
<td>71.74</td>
<td>24</td>
<td>71.96</td>
<td>12.84</td>
</tr>
<tr>
<td>Posttest</td>
<td>23</td>
<td>77.30</td>
<td>10.39</td>
<td>75.05</td>
<td>24</td>
<td>76.29</td>
<td>9.80</td>
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<td></td>
<td>4.33</td>
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</tr>
<tr>
<td>4-5</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>46</td>
<td>22.87</td>
<td>4.60</td>
<td>49.72</td>
<td>32</td>
<td>24.59</td>
<td>4.19</td>
</tr>
<tr>
<td>Posttest</td>
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<td>30.70</td>
<td>4.13</td>
<td>66.73</td>
<td>32</td>
<td>24.34</td>
<td>5.56</td>
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<tr>
<td>Difference</td>
<td>7.83</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.25)</td>
<td></td>
</tr>
</tbody>
</table>
The kindergarten through first grade post mean scores by treatment and theme indicated the treatment group answered 77.89 percent of the questions correctly and the control group answered 72.55 percent correctly. The treatment and control groups were most knowledgeable about Theme 5 (Food, Nutrition and Health) followed by Theme 4 (Business and Economics), with the treatment group being more knowledgeable about Theme 1 (Understanding Food and Fiber Systems), while the control group was more knowledgeable about Theme 3 (Science, Technology and Environment). The treatment and control groups were least knowledgeable about Theme 2 (History, Geography and Culture).

The second through third grade post mean scores by treatment and theme indicated the treatment group answered 75.05 percent of the questions correctly and the control group answered 74.07 percent correctly. The treatment group was most knowledgeable about Theme 3 (Science, Technology and Environment) followed by Theme 1 (Understanding Food and Fiber Systems) and Theme 5 (Food, Nutrition and Health). The control group was most knowledgeable about Theme 1 (Understanding Food and Fiber Systems) followed by Theme 3 (Science, Technology and Environment) and Theme 4 (Business and Economics). The treatment and control groups were least knowledgeable about Theme 2 (History, Geography and Culture).

The fourth through fifth grade post mean scores by treatment and theme indicated the treatment group answered 66.73 percent of the questions correctly and the control group answered 52.91 percent correctly. The treatment group was most knowledgeable about Theme 2 (History, Geography and Culture) followed by Theme 3 (Science, Technology and Environment) and Theme 5 (Food, Nutrition and Health). The control groups were most knowledgeable about Theme 3 (Science, Technology and Environment) followed by Theme
Table 7. Summary of K-5 Mean Pretest and Posttest Scores by AITC Treatment and Control for Themes

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>% Correct</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>% Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-1 Treatment</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Theme 1</td>
<td>47</td>
<td>12.06</td>
<td>3.53</td>
<td>50.00</td>
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<td>3.33</td>
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<td>0.74</td>
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<td>0.84</td>
<td>40.00</td>
</tr>
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<td>9.32</td>
<td>0.86</td>
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<td></td>
<td>8.83</td>
<td>1.53</td>
<td>60.00</td>
</tr>
<tr>
<td>K-1 Control</td>
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<td></td>
<td>4.09</td>
<td>0.96</td>
<td>42.86</td>
<td></td>
<td>3.66</td>
<td>0.97</td>
<td>57.14</td>
</tr>
<tr>
<td>Theme 5</td>
<td></td>
<td>1.53</td>
<td>1.11</td>
<td>38.25</td>
<td></td>
<td>1.53</td>
<td>1.02</td>
<td>75.00</td>
</tr>
</tbody>
</table>

Note: Theme 1 (Understanding Food and Fiber Systems); Theme 2 (History, Geography and Culture); Theme 3 (Science, Technology and Environment); Theme 4 (Business and Economics); Theme 5 (Food, Nutrition and Health)
1 (Understanding Food and Fiber Systems) and Theme 4 (Business and Economics). The treatment was least knowledgeable about Theme 4 (Business and Economics) and Theme 5 (Food, Nutrition and Health). The control group was least knowledgeable about Theme 2 (History, Geography and Culture) followed by Theme 5 (Food, Nutrition and Health). **Objective 4: Compare theme score mean gains between treatment and control groups in student knowledge about agriculture, before and after AITC instruction, for each grade grouping (K-1, 2-3, 4-5) (see Table 8).**

Students’ mean and percent correct scores by thematic area of the FFSL Framework allowed the researcher to verify the level of agricultural knowledge demonstrated by the students receiving AITC instruction and those who did not receive AITC instruction. This did not allow for the determination of students’ acquisition of agricultural knowledge. To reflect the students’ acquisition of agricultural knowledge, the difference between the mean posttest and the pretest score was calculated as the gain score.

The kindergarten through first grade posttest and pretest mean score differences by treatment and themes reflected increase of 1.07 and 3.62 for the treatment and control groups with standard deviation of 0.18 for the treatment group and a decrease of 1.98 for the control group. The treatment and control groups’ highest knowledge increases were in Theme 3 (Science, Technology and Environment) followed by Theme 2 (History, Geography and Culture) and Theme 1 (Understanding Food and Fiber Systems). The treatment group indicated an increase in knowledge about Theme 4 (Business and Economics) while the control groups reflected a decrease. The control group had an increase for Theme 5 (Food, Nutrition and Health) and the treatment group showed a decrease.
Table 8. *Comparison of Mean Gain Scores Between AITC Treatment and Control Groups by Themes*

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T</td>
<td>C</td>
<td>T</td>
</tr>
<tr>
<td>K-1 Treatment/Control</td>
<td>47</td>
<td>24</td>
<td>1.07</td>
</tr>
<tr>
<td>Overall gain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Theme 1 (Understanding Food and Fiber Systems)</td>
<td>0.13</td>
<td>1.15</td>
<td>(0.20)</td>
</tr>
<tr>
<td>Theme 2 (History, Geography and Culture)</td>
<td>0.39</td>
<td>1.04</td>
<td>(0.21)</td>
</tr>
<tr>
<td>Theme 3 (Science, Technology and Environment)</td>
<td>0.83</td>
<td>1.43</td>
<td>(0.18)</td>
</tr>
<tr>
<td>Theme 4 (Business and Economics)</td>
<td>0.21</td>
<td>-6.07</td>
<td>0.10</td>
</tr>
<tr>
<td>Theme 5 (Food, Nutrition and Health)</td>
<td></td>
<td></td>
<td>(0.49)</td>
</tr>
<tr>
<td>2-3 Treatment/Control</td>
<td>54</td>
<td>23</td>
<td>3.43</td>
</tr>
<tr>
<td>Overall gain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Theme 1 (Understanding Food and Fiber Systems)</td>
<td>0.58</td>
<td>1.50</td>
<td>(0.06)</td>
</tr>
<tr>
<td>Theme 2 (History, Geography and Culture)</td>
<td>2.18</td>
<td>(0.63)</td>
<td>(1.02)</td>
</tr>
<tr>
<td>Theme 3 (Science, Technology and Environment)</td>
<td>1.04</td>
<td>1.00</td>
<td>1.15</td>
</tr>
<tr>
<td>Theme 4 (Business and Economics)</td>
<td>1.15</td>
<td>1.71</td>
<td>(0.11)</td>
</tr>
<tr>
<td>Theme 5 (Food, Nutrition and Health)</td>
<td>-1.52</td>
<td>0.75</td>
<td>0.13</td>
</tr>
<tr>
<td>4-5 Treatment/Control</td>
<td>46</td>
<td>32</td>
<td>13.02</td>
</tr>
<tr>
<td>Overall gain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Theme 1 (Understanding Food and Fiber Systems)</td>
<td>10.50</td>
<td>(0.22)</td>
<td>(0.55)</td>
</tr>
<tr>
<td>Theme 2 (History, Geography and Culture)</td>
<td>7.59</td>
<td>0.32</td>
<td>0.15</td>
</tr>
<tr>
<td>Theme 3 (Science, Technology and Environment)</td>
<td>(3.22)</td>
<td>0.10</td>
<td>(0.31)</td>
</tr>
<tr>
<td>Theme 4 (Business and Economics)</td>
<td>0.11</td>
<td>(0.43)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>Theme 5 (Food, Nutrition and Health)</td>
<td>(1.74)</td>
<td>0.00</td>
<td>(0.06)</td>
</tr>
</tbody>
</table>
The second through third grade posttest and pretest mean score differences by treatment and themes indicated increases of 3.43 and 4.33 for the treatment and control groups, respectively. The standard deviation of 0.09 for the treatment group and a decrease of 3.87 for the control group were reflected. The treatment group was most knowledgeable about Theme 2 (History, Geography and Culture) while the control group indicated a decrease. The control group was most knowledgeable about Theme 1 (Understanding Food and Fiber Systems) while the treatment group reflected a smaller increase. The treatment and control groups reflected similar knowledge gains in Theme 4 (Business and Economics). The control group was more knowledgeable about Theme 5 (Food, Nutrition and Health) with the treatment group exhibiting a decrease.

The fourth through fifth grade posttest and pretest mean score differences by treatment and themes reflected increase of 13.02 for the treatment and a 0.23 decrease in the control group with standard deviation decrease of 0.79 for the treatment group and a increase of 1.17 for the control group.

The treatment group was most knowledgeable about Theme 1 (Understanding Food and Fiber Systems) and Theme 2 (History, Geography and Culture) followed by a slight increase in Theme 4 (Business and Economics). The treatment group indicated decreases in Theme 3 (Science, Technology and Environment) and Theme 5 (Food Nutrition and Health). The control group reflected slight increases in Theme 2 (History, Geography and Culture) and Theme 3 (Science, Technology and Environment). No gain was indicated for Theme 5 (Food Nutrition and Health). Decreases in agricultural knowledge were found for Theme 4 (Business and Economics) and Theme 1 (Understanding Food and Fiber Systems).
Objective 5: Develop a profile of student knowledge about agriculture, before and after AITC instruction based on pre- and posttest mean scores, for each grade grouping (K-1, 2-3, 4-5) by the five thematic areas of the Food and Fibers Literacy (FSSL) Framework (see Table 9).

The K-1 group demonstrated equal knowledge for both treatment and control groups about Theme 5 (Food, Nutrition and Health) in both pre- and posttests. While treatment and control groups indicated the similar knowledge about Theme 4 (Business and Economics) in the pretests, this knowledge dropped to fourth and fifth places in the posttests with Theme 1 (Understanding the Food and Fiber Systems) moving to the second most knowledgeable theme in the posttests. Theme 2 (History, Geography and Culture) for treatment and control groups posttests exhibited a third place knowledge while Theme 3 (Science, Technology and Environment) remained the least knowledgeable area for the treatment group in both pre-and posttests.

The 2-3 groups demonstrated the least knowledge about Theme 2 (History, Geography and Culture) for the both treatment and control groups in the pretests with Theme 4 (Business and Economics) becoming the least knowledgeable for the both treatment and control groups in the posttests. The treatment group was most knowledgeable about Theme 3 (Science, Technology and Environment) in the pretests and most knowledgeable about Theme 5 (Food, Nutrition and Health) in the posttests. The control group was most knowledgeable about Theme 1 (Understanding the Food and Fiber Systems) in the pretests and most knowledgeable about Theme 2 (History, Geography and Culture) in the posttests.
Table 9. *Profile of Student Knowledge about Agriculture, Before and After AITC Instruction, for Each Grade Grouping by Theme (1-Most Knowledgeable to 5-Least Knowledgeable)*

<table>
<thead>
<tr>
<th>Treatment, Control</th>
<th>K-1 Pretest</th>
<th>K-1 Posttest</th>
<th>2-3 Pretest</th>
<th>2-3 Posttest</th>
<th>4-5 Pretest</th>
<th>4-5 Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theme 1</td>
<td>3,5,2</td>
<td>2,2,1</td>
<td>2,1,3</td>
<td>3,4,5</td>
<td>5,2,2</td>
<td>2,2,1</td>
</tr>
<tr>
<td>Theme 2</td>
<td>4,4,3</td>
<td>3,3,5</td>
<td>5,5,4</td>
<td>4,1,1</td>
<td>1,4,2</td>
<td>5,3,5</td>
</tr>
<tr>
<td>Theme 3</td>
<td>5,3,5</td>
<td>5,4,1</td>
<td>1,2,4</td>
<td>2,3,3</td>
<td>2,1,1</td>
<td>1,5,4</td>
</tr>
<tr>
<td>Theme 4</td>
<td>2,2,2</td>
<td>4,5,4</td>
<td>4,3,5</td>
<td>5,5,3</td>
<td>4,3,4</td>
<td>4,4,4</td>
</tr>
<tr>
<td>Theme 5</td>
<td>1,1,1</td>
<td>1,1,3</td>
<td>3,4,2</td>
<td>1,2,1</td>
<td>3,5,3</td>
<td>3,1,1</td>
</tr>
</tbody>
</table>

Note: Theme 1 (Understanding Food and Fiber Systems); Theme 2 (History, Geography and Culture); Theme 3 (Science, Technology and Environment); Theme 4 (Business and Economics); Theme 5 (Food, Nutrition and Health) and 1-Most Knowledgeable, 5-Least Knowledgeable
For the 4-5 groups, the treatment group indicated the most knowledge about Theme 2 (History, Geography and Culture) in the pretests, and Theme 3 (Science, Technology and Environment) in the posttests. The control group was most knowledgeable about Theme 3 (Science, Technology and Environment) in the pretests, and most knowledgeable about Theme 5 (Food, Nutrition and Health) in the posttests. The treatment group demonstrated the least knowledge about Theme 1 (Understanding the Food and Fiber Systems) in the pretests and Theme 2 (History, Geography and Culture) in the posttests. The control group showed limited knowledge about Theme 5 (Food, Nutrition and Health) in the pretests and Theme 3 (Science, Technology and Environment) in the posttests.

**Objective 6: Develop a demographic profile of students that participated in this study.**

**Results of Student Demographic Questionnaire**

Section One of the instrument included four questions identifying aspects of student demographic information: including age, gender, ethnicity, and the number of years the student received Agriculture in the Classroom (AITC) instruction. Frequencies and percentages were calculated for each identified gender. The students were generally distributed evenly by gender, however, in Schools 1, 3, and 4, the number of males was 3.3 to 14.5% higher than females. Only School 2 demonstrated a 3.3% higher female to male count (see Table 10).

**Solomon Four-Group Design Analysis**

An analysis of variance of the data using the Solomon Four-Group design analysis, found no indication of pretest sensitization, or test reactivity effect, was present in this study (see Appendix H).

This finding is supported by the comparison of mean scores based on the administration of a pretest administration or no pretest administration (See Figure 4).
Table 10. Distribution of Study Participants by Frequency and Gender

<table>
<thead>
<tr>
<th>School Number</th>
<th>Male</th>
<th>Female</th>
<th>Total n</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>1</td>
<td>77</td>
<td>53.9</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>38</td>
<td>47.2</td>
<td>43</td>
</tr>
<tr>
<td>3</td>
<td>47</td>
<td>51.6</td>
<td>44</td>
</tr>
<tr>
<td>4</td>
<td>63</td>
<td>57.3</td>
<td>47</td>
</tr>
<tr>
<td>Total</td>
<td>225</td>
<td></td>
<td>204</td>
</tr>
</tbody>
</table>
Figure 4: Mean Score Based on Administering Pretest or No Pretest

Where 1 row excluded
Each error bar is constructed using 1 standard error from the mean.
As a result of this finding, the researcher reexamined only the posttest mean scores, by individual grade levels, i.e. K, 1, 2, 3, 4, and 5 as opposed to grade groupings of K-1, 2-3 and 4-5. A one-way analysis of variance (ANOVA) between subjects was conducted to compare the effect of the posttest mean scores by grade and test type, i.e. treatment or control. The grade effect resulted in lost degrees of freedom and was examined separately.

There was a significant effect on the posttest mean scores at p < 0.05 for type condition; control [F(5,5) = 9.98, p = 0.0123] and treatment [F(5,5) = 100.471, p < .0001]. Additionally, a one-way analysis of variance examined compare posttest mean scores by grade. The comparison was significant at p < 0.05 for grade effect [F(5,17) = 36.67, p < .0001].

The researcher also examined a potential theme effect. The one-way analyses for theme where p < 0.05 resulted in the following findings: Theme 1 [F(5, 17) = 38.08, p = <.0001]; Theme 2 [F(5, 17) = 70.77, p < .0001]; Theme 3 [F(5, 17) = 91.87, p < .0001]; Theme 4 [F(5, 17) = 75.07, p < .0001]; and Theme 5 was not significant. (see Appendix H – Analysis of Variance Tables).

**Summary of Findings**

1. A Solomon Four-Group analysis indicated that pretest sensitization, or test reactivity effect, was not present in the four-school posttest examination. This suggested the pretest did not drive the posttest, but the treatment drove the posttest.

2. Elementary school students participating in this study demonstrated that agricultural literacy knowledge was increased for all groups except the 4-5 grade control group, which indicated a 0.25 decrease in agricultural literacy knowledge where pre-and posttests were administered.
3. A Solomon Four-Group analysis indicated that pretest sensitization, or test reactivity effect, was not present in the four-school posttest examination. This suggested the pretest did not drive the posttest, but the treatment drove the posttest.

4. Elementary school students participating in this study demonstrated that agricultural literacy knowledge was increased for all groups except the 4-5 grade control group, which indicated a 0.25 decrease in agricultural literacy knowledge where pre-and posttests were administered.

5. Given the findings in Number 1, the pretest mean scores were dropped and the posttest only mean scores for each classroom, as opposed to grade group, were analyzed.

6. Student demographic profiles for this study indicated a slightly greater male to female ratio, 225 to 204 respectively.

7. Schools varied in student enrollment for this study with numbers from 81 to 148. Class size varied from 11 to 23 students per grade.

8. School demographics showed low-income student population varied from 37.9% in School 2 to 64.6 % in School 1.

9. School demographics indicated students receiving special education services varied from 8.1% in School 2 to 18.8% in School 1.

10. Instructional spending per pupil ranged from $5,151 for School 2 to $5,438 for School 1, and included only the activities directly dealing with the teaching of students or the interaction between teachers and students.

11. Property tax contributions to school districts ranged from $295,983 for School 2 to $3,917,616 for School 4.
12. The fourth through fifth grade treatment group achieved the highest mean score gain with fourth through fifth grade control group earning the lowest mean score gain of all grade groupings. Second through third grade treatment and control groups exhibited the highest means score gains of all grade groupings. Kindergarten through first grade treatment and control groupings indicated positive mean score gains.

13. The fourth through fifth grade treatment grouping scored the highest mean scores in the Understanding Food and Fiber Systems theme and in the History, Geography and Culture theme and the lowest in the Science, Technology and Environment theme. The fourth through fifth control group indicated negative mean score gains in all themes except History, Geography and Culture, which scored a slight mean score gain.

14. The second through third grade treatment grouping indicated the highest mean core gain in History, Geography and Culture theme followed by Business and Economics theme and Science, Technology and Environment theme. A slight increase in mean score gain was scored in Understanding Food and Fiber Systems theme. The Food, Nutrition and Health theme indicated negative mean score gain.

15. The kindergarten through first grade treatment group had slight increased mean score gains in Science, Technology and Environment theme, followed by History, Geography and Culture theme, Business and Economics theme and Understanding Food and Fiber Systems theme. Food, Nutrition and Health indicated a negative mean score gain. The kindergarten through first grade control group indicated the highest mean score gain in Food Nutrition and Health theme followed by Science, Technology and Environment theme, Understanding Food and Fiber Systems theme,
and History, Geography and Culture theme scoring similarly. The Business and Economics theme had the highest negative mean score gain of all grade groupings.

16. This study was compared to findings in a previous four state agricultural literacy study conducted by Leising, Pense, and Portillo, from June 15, 2001 through September 14, 2003, entitled, “The Impact of Selected Agriculture in the Classroom Teachers on Student Agricultural Literacy”. Only published data was available for comparisons. In comparing this study to the previous study, the researcher found students in Illinois public elementary schools demonstrated positive mean gain scores for both treatment and control groups (K-1 and 2-3), except for 4-5 control group, which indicated a slight 0.25 decrease in agricultural literacy knowledge. While the differences in mean gain scores was not as sizeable as the Leising et al. study, the researcher contributes the smaller mean score gains to the fact that Illinois was one of the earliest adopters of the Agriculture in the Classroom instructional program. Therefore, Illinois public elementary students had potential access to agricultural literacy materials possibly earlier than public elementary students who participated in the previous study.

17. Relating the Illinois public elementary students’ agricultural knowledge by themes with the Leising et al. study, the K-1 group were most knowledgeable about agricultural topics regarding Theme 5 (Food, Nutrition and Health) as was found in the previous study, followed by Theme 1 (Understanding the Food and Fiber Systems). The students in the Leising et al. study were similarly knowledgeable about Theme 4 (Business and Economics) and Theme 2 (History, Geography and Culture) as were the students in the this study.
18. The 2-3 treatment and control groups in the Leising et al. study were most knowledgeable about Theme 1 (Understanding the Food and Fiber Systems). The treatment group followed with Theme 2 (History, Geography and Culture) and Theme 3 (Science, Technology and Environment). The treatment group was least knowledgeable about agricultural topics regarding Theme 4 (Business and Economics) as was the 2-3 treatment and control groups in this study. The treatment group in this study was most knowledgeable about Theme 3 (Science, Technology and Environment) in the pretest and Theme 5 (Food, Nutrition and Health) in the posttests. Similarly, the pretest control group in this study was knowledgeable about agricultural topics involving Theme 1 (Understanding the Food and Fiber Systems) as was the control group in the Leising et al. study. However, the posttest control group in this study was more knowledgeable regarding Theme 2 (History, Geography and Culture) than the control group in the previous study, which was the least knowledgeable.

19. The 4-5 treatment group in this study was most knowledgeable about agricultural topics involving the Theme 2 (History, Geography and Culture) in the pretests and Theme 3 (Science, Technology and Environment) in the posttests. The treatment group demonstrated the least agricultural knowledge about Theme 1 (Understanding the Food and Fiber Systems) in the pretests and Theme 2 (History, Geography and Culture) in the posttests. The control pretest group was most knowledgeable about Theme 3 (Food, Nutrition and Health) and least knowledgeable regarding agricultural topics in Theme 3 (Science, Technology and Environment) in the posttest. In the Lesing et al. study, both treatment and control groups were most
knowledgeable regarding Theme 2 (History, Geography and Culture) as was this study’s treatment pretest group and least knowledgeable about agricultural topics regarding Theme 4 (Business and Economics).
CHAPTER 5

CONCLUSIONS, RECOMMENDATIONS, AND IMPLICATIONS

Summary

Purpose

The purpose of this study was to assess the agricultural knowledge of selected Illinois classrooms of public elementary school students in kindergarten through fifth grades, and determine if gaps exist in the current K-12 educational curriculum regarding instructional topics that would lead to agricultural literacy. To accomplish this, the study utilized the original instruments based on the Food and Fiber Systems Literacy (FFSL) Framework standards and benchmarks for collecting data on the agricultural knowledge of Illinois public elementary school students.

Objectives

To accomplish the purpose of the study, the research project was focused on the following research objectives:

1. Develop a demographic profile of schools that participated in the study.

2. Assess differences using sum mean scores between AITC treatment groups and control groups in student knowledge about agriculture, before and after AITC instruction, for each grade grouping (K-1, 2-3, 4-5).

3. Assess differences in sum mean scores between AITC treatment groups and control groups in student knowledge about agriculture, before and after AITC instruction, using the five thematic areas of the Food and Fiber Systems Literacy (FSSL) Framework between schools for each grade grouping (K-1, 2-3, 4-5).
4. Assess theme mean score gains between treatment and control groups in student knowledge about agriculture, before and after AITC instruction, for each grade grouping (K-1, 2-3, 4-5).

5. Develop a profile of student knowledge about agriculture, before and after AITC instruction based on pre- and posttest mean scores, for each grade grouping (K-1, 2-3, 4-5) by the five thematic areas of the Food and Fibers Literacy (FSSL) Framework.

6. Develop a demographic profile of students who participated in this study.

Study Design and Procedure

This study utilized a quasi-experimental nonequivalent control group, using a pretest and a posttest, as described by Cook and Campbell (1979). Quasi-experimental designs are used where non-randomization of treatment groups are allowed (Ary, Jacobs, & Sorenson, 2010). Some suggest pretests may influence results (Blakstad, 2008). However, this is one of the more frequently used designs in social sciences to measure the degree of change occurring as a result of a treatment or intervention (Shuttleworth, 2009). Cook and Campbell (1979) noted while not a true experimental design by name, quasi-experimental designs could sometimes provide a more natural, generalizable environment that better establishes effectiveness (as opposed to efficacy, typically associated with medical research).

Treatment and control groups were selected in each participating FCAE District within Illinois. The treatment group was comprised of classrooms (K-5) in schools that utilize AITC Literacy Coordinators, training, and/or materials in the academic year 2015-2016. The control group was comprised of classrooms (K-5) in schools that did not utilize
AITC Literacy Coordinators, training, and/or materials in the academic year 2015-2016. The control groups were selected from schools that were similar in size and geographic location to the treatment groups. A pretest and posttest were administered to students to measure their knowledge about agriculture.

Population

The population of this study included a cross-section of selected public elementary school classrooms across the state of Illinois during the 2015-2016 academic school year. As random sampling was not feasible based on unique characteristics of each school and the availability of subjects in intact groups, this study employed a purposive sample (Lund Research Ltd., 2012; Wiersma, 1995).

One form of purposive sampling technique, or homogeneous sampling, contains units, which are similar in terms of age and background (Black, 2010). Worthen, Sanders and Fitzpatrick (1997, p. 359) employ the term “judgment sampling”, the strength of which is found in describing a subgroup, which permits a better understanding of the program as a whole. This non-probability sampling approach is based on particular characteristics or judgments, which will best enable the research questions to be answered; these are specific to the characteristics of a particular group and is not to be considered a weakness (Explorable, 2016; Lund Research Ltd., 2012). In this study, the researcher selected the schools based on the knowledge and professional judgment of the Illinois County AITC Literacy Coordinators who participated, and not based solely on the researcher’s knowledge or judgment.

The target population was 500 students, similar in number per state, to the original study conducted by Leising, et al. in 2003. The population includes students in schools
whose student population varied from 81 to 148 students. Classroom sizes varied from 11 to 23. Intact groups of students reflecting diverse academic ability, both genders, and all present ethnicities were included in the population. The final population was 430 students rather than the targeted population of 500 students.

Instrumentation

A review of the literature indicated previous studies utilized a variety of data collection instruments. Some researchers elected to create a new instrument to achieve research objectives (Doerfert D., 2003). Other researchers developed an instrument based on the 11 agricultural literacy objectives identified by Frick, et al. (Frick, Kahler, & Miller, 1990). Doerfert (2003) noted that a select number of researchers chose to utilize instruments developed by another researcher(s).

The researcher of this study chose to utilize the original instruments, developed and tested by Leising and Igo, based on the K-5th grade benchmarks of the FFSL Framework of standards and benchmarks for agricultural literacy (Leising, Igo, Heald, Hubert, & Yamamoto, 1998) (See Appendix E- Food and Fiber Systems Literacy Tests for students in grades K-5). At the time of this study, no other instrument had been developed, tested, or was available to assess agricultural literacy knowledge of students in K-5.

Data Collection

In order to obtain the broadest cross-section of elementary public school students in Illinois, classroom test sites were purposively selected from the five FCAE Districts by randomly selected county Agriculture Literacy Coordinators and roughly represented by the FCAE Districts. One to six schools in each district were selected for this study resulting in a total of 31 potential study sites.
The instrument, for each appropriate grade level, was administered at each site by the same teacher (See Appendix E-Food and Fibers Systems Literacy Tests). To ensure anonymity, each instrument was given a six-digit number in an effort to separate test scores, FCAE Districts, school identities, grade levels, as well as the identities of individual students.

Demographic information of each school was based on documents the schools submitted for state and federal funding as well as qualitative observations of the researcher or AITC Agriculture Literacy Coordinators.

Data Analysis

Each student’s six-digit code number was pre-stamped by the researcher on each grade appropriate instrument. The identities of the students were not connected to the student numbers on the instruments, but were used to ensure that each student was scored separately and participated in both pretest and posttest, and was grouped according to grade level and school. The researcher kept a record of the students’ names and students’ identification numbers. This list was destroyed after completion of data collection to ensure anonymity.

Upon completion and retrieval of the pretest instruments, tests were scored by hand and coded into a Microsoft Excel spreadsheet (Microsoft Excel for Mac 2011, Version 14.6.0) for analysis purposes. A data file was created for import to JMP Pro Version 13.0.0 and was used to perform all statistical procedures and analysis of pretest and posttest group data in conjunction with the stated purpose and objectives of this study.

Descriptive statistics were utilized to report demographic characteristics of the respondent students. The JMP Pro Version 13.0.0 was used to calculate frequencies and
percentages of study respondents by age, gender, and grade. Descriptive statistics were also utilized to describe and summarize observations; specifically, percentages, means, and standard deviations.

Statistical Treatment Using Solomon Four-Group Design

Over 65 years ago, Solomon introduced a new form of experimental design referred to as the Solomon four-group design (Solomon, 1949). Campbell and Stanley described the Solomon four-group design (Campbell & Stanley, 1963) as a one-treatment experimental design. However, the researchers found the Solomon four-group design was the only design able to assess the presence of pretest sensitization or test reactivity (Huck & Chuang, 1977). Huck and Sandler (1973, p.54) noted that “exposure to the pretest increases … the Ss’ sensitivity to the experimental treatment” and prevented generalizations between the pretested group and the unpretested group. Therefore, the Solomon four-group design added a higher degree of external validity in addition to the internal validity leading Helmstadter (1970, p. 110) to conclude it (i.e., the Solomon 4-group design) was the most desirable of all basic experimental designs.

Conclusions may be more complicated using the Solomon design due to the number of comparisons it allows (Oliver & Berger, 1980). This intricacy may dissuade researchers from using Solomon. With increased negativity toward allowing outside testing in schools, such as the researcher encountered firsthand, if Solomon could demonstrate that a pretest was unnecessary and did not drive the outcome, school administrators may be more amenable to allowing outside testing in their schools or school districts in which only a posttest would be administered.
Major Findings

A statistical analysis using the Solomon Four-Group Design found pretest sensitization, or test reactivity effect, was not present in this study. This finding is significant in that it could persuade school administrators to allow outside research studies access to their educational systems, as only a single posttest would be required. This was the single greatest barrier in this study—the time requirements school administrators perceived to be too burdensome to allow for pre- and posttesting of their student population. Without this obstacle, future research studies may gain access into educational systems more readily.

Illinois public elementary students who participated in this study demonstrated they possess varying levels of knowledge about agriculture using the Food and Fibers Systems Literacy with regards to the five thematic areas of the FFSL. All grade groups (K-1, 2-3, 4-5) for both treatment and control groups indicated positive gains in overall agricultural knowledge with the exception of the 4-5 control group, which showed a slight decrease in their knowledge about agricultural topics.

The kindergarten through first grade treatment and control groups were most knowledgeable about agricultural topics related to Theme 5 (Food, Nutrition and Health), and were least knowledgeable about agricultural topics regarding Theme 2 (History, Geography and Culture).

The second through third grade treatment group was most knowledgeable about agricultural topics associated with Theme 3 (Science, Technology and Environment) while the control group was most knowledgeable about agricultural topics as related to Theme 1 (Understanding the Food and Fibers System). Both treatment and control groups
demonstrated limited agricultural knowledge regarding Theme 2 (History, Geography and Culture).

The fourth through fifth grade treatment group was most knowledgeable with agricultural topics relating to Theme 2 (History, Geography and Culture) with the control group most knowledgeable regarding Theme 3 (Science, Technology and Environment). Both groups demonstrated the least agricultural knowledge relating to Theme 4 (Business and Economics) and Theme 5 (Food, Nutrition and Health).

Findings by Objectives

Objective 1: Develop a demographic profile of schools that participated in the study.

The schools, which participated in the study, reflected the diversity of the very vertical (north/south) state of Illinois. Student enrollment varied from 81 to 148, which are similar with other schools in their regions of the state whether a rural school or a suburban school.

School demographics indicated low-income student population varied from 37.9% to 64.6%. Additionally, schools with students receiving special education services varied from 8.1% to 18.8%.

Instructional spending per pupil ranged from $5,151 to $5,438, and included only the activities directly dealing with the teaching of students or the interaction between teachers and students. Property tax contributions to school districts, a major source of local school funding, ranged from $295,983 for to $3,917,616.

Objective 2: Assess differences in posttest mean scores between AITC treatment group and control group in student knowledge about agriculture, before and after AITC instruction, for each grade grouping (K-1, 2-3, 4-5).
The fourth through fifth grade treatment group achieved the highest mean score gain with fourth through fifth grade control group earning the lowest mean score gain of all grade groupings. Second through third grade treatment and control groups exhibited the highest mean score gains of all grade groupings. Kindergarten through first grade treatment and control groupings indicated positive mean score gains.

Objective 3: Assess differences in posttest mean scores between AITC treatment groups and control groups in student knowledge about agriculture, before and after AITC instruction, using the five thematic areas of the Food and Fiber Systems Literacy (FSSL) Framework between schools for each grade grouping (K-1, 2-3, 4-5).

The kindergarten through first grade post mean scores by treatment and theme indicated the treatment group answered 77.89 percent of the questions correctly and the control group answered 72.55 percent correctly. The treatment and control groups were most knowledgeable about Theme 5 (Food, Nutrition and Health) followed by Theme 4 (Business and Economics), with the treatment group being more knowledgeable about Theme 1 (Understanding Food and Fiber Systems), while the control group was more knowledgeable about Theme 3 (Science, Technology and Environment). The treatment and control groups were least knowledgeable about Theme 2 (History, Geography and Culture).

The second through third grade post mean scores by treatment and theme indicated the treatment group answered 75.05 percent of the questions correctly and the control group answered 74.07 percent correctly. The treatment group was most knowledgeable about Theme 3 (Science, Technology and Environment) followed by Theme 1 (Understanding Food and Fiber Systems) and Theme 5 (Food, Nutrition and Health). The control group was most knowledgeable about Theme 1 (Understanding Food and Fiber Systems) followed by
Theme 3 (Science, Technology and Environment) and Theme 4 (Business and Economics). The treatment and control groups were least knowledgeable about Theme 2 (History, Geography and Culture).

The fourth through fifth grade post mean scores by treatment and theme indicated the treatment group answered 66.73 percent of the questions correctly and the control group answered 52.91 percent correctly. The treatment group was most knowledgeable about Theme 2 (History, Geography and Culture) followed by Theme 3 (Science, Technology and Environment) and Theme 5 (Food, Nutrition and Health). The control groups were most knowledgeable about Theme 3 (Science, Technology and Environment) followed by Theme 1 (Understanding Food and Fiber Systems) and Theme 4 (Business and Economics). The treatment was least knowledgeable about Theme 4 (Business and Economics) and Theme 5 (Food, Nutrition and Health). The control group was least knowledgeable about Theme 2 (History, Geography and Culture) followed by Theme 5 (Food, Nutrition and Health).

Objective 4: Compare theme posttest mean score gains between treatment and control groups in student knowledge about agriculture, before and after AITC instruction, for each grade grouping (K-1, 2-3, 4-5).

The fourth through fifth grade treatment grouping scored the highest mean scores in the Understanding Food and Fiber Systems theme and in the History, Geography and Culture theme, and the lowest in the Science, Technology and Environment theme. The fourth through fifth control group indicated negative mean score difference, or loss rather than gain, in all themes except History, Geography and Culture, which scored a slight mean score gain.
The second through third grade treatment grouping indicated the highest mean score gain in the History, Geography and Culture theme, followed by the Business and Economics theme and Science, Technology and Environment theme. A slight increase in mean score gain was achieved in Understanding Food and Fiber Systems theme. The Food, Nutrition and Health theme indicated a negative mean score difference, or a loss rather than gain.

The kindergarten through first grade treatment group had slight increased mean score gains in the Science, Technology and Environment theme, followed by the History, Geography and Culture theme, Business and Economics theme and Understanding Food and Fiber Systems theme. Food, Nutrition and Health indicated a negative mean score difference. The kindergarten through first grade control group indicated the highest mean score gain in the Food Nutrition and Health theme followed by the Science, Technology and Environment theme, Understanding Food and Fiber Systems theme, and History, Geography and Culture theme. The Business and Economics theme had the highest negative mean score difference of all grade groupings.

Objective 5: Develop a demographic profile of students that participated in this study.

Student demographic profiles for this study indicated a slightly greater male to female ratio, 225 to 204, respectively, with three schools indicating the number of males was 3.3 to 14.5% higher than females. One school demonstrated a 3.3% higher female to male count.

Racial demographics indicated the following: White (84.8% to 95.6%), African-American or Black (2.2%), Hispanic (10.7%), Asian (0.7%), Pacific Islander (0.9%), and multi-racial (two or more races) (0.4% to 3.9%).
Conclusions

The conclusions in this study were not generalized beyond the 430-selected K-5th grade students in the four Illinois elementary schools who participated in this study. The major findings presented in this study support the following conclusions:

1. Based upon the demographic data collected, it was found that students attending the four schools varied in population and property tax contributions to the respective school districts. However, instructional spending per student was not too different. The ethnic composition of the student population at each school was similar. Male to female ratio favored male students slightly over female students.

2. Both AITC treatment and control group students possessed some agricultural knowledge regarding the five thematic areas of the Food and Fiber Systems Literacy (FSSL) Framework.

3. Both groups, the AITC treatment group and the control group, showed increased mean score gains about agricultural knowledge for all grade groups (K-1, 2-3, 4-5) with the exception of the fourth through fifth control group.

4. Student agricultural knowledge scores across all grade groupings differed between pretest and posttest scores in three of the Food and Fiber Systems Literacy Framework themes: Business and Economics; History, Geography and Culture; and Science, Technology and Environment.

5. Most students in the study displayed similar levels of knowledge for the theme, Understanding the Food and Fiber Systems, a foundational subject area in the Food and Fiber Systems Literacy Curriculum Framework.
6. The overall agricultural knowledge of K-5 grade school students at the four Illinois elementary schools that participated in this study demonstrated that they do possess varying levels of agricultural literacy, as defined by the FFSL Framework.

**Recommendations**

The following recommendations were based upon the researcher’s perceptions while conducting this study, examination of the major findings of the study, conversations with educators before and during the study, and the conclusions of the overall research project.

1. This study utilized an instrument based upon the Food and Fibers Systems Literacy standards and benchmarks for grades K-5. It was previously piloted tested at schools with students not associated with this study.

   A. The five themes, as well as the standards and benchmarks, provide a diagnostic tool for adoption and incorporation of an instructional program into current curriculum. Teachers, as well as curriculum specialists, can use the instrument to identify current gaps in their students’ knowledge about agriculture and it’s related fields.

   B. At the time of this study, no instrument, other than the FFSL framework instrument, had been developed to assess the agricultural literacy of K-5 students. An updated instrument, especially one that aligns agricultural literacy with the Common Core Standards (CCS) and the Next Generation Science Standards (NGSS) is, in the opinion of this researcher, critically needed. If an instrument were so designed, adoption and implementation into current school curricula by teachers would be more feasible.
C. The redesign of the original testing instrument is critically needed. With the schools’ adoption of computer technology, i.e. iPads, tablets, etc., into the classroom, an interactive testing instrument, with use of color and sound, may reveal the strengths and weaknesses of the current agricultural literacy program more objectively.

D. With rapid changes in the fields of agriculture, science, technology, environment, and culture, etc., a flexible system for updating, deleting, and changing outdated facts and figures in a redesigned testing instrument needs to be implemented to remain relevant with the latest technologies and, thus allow for more accurate measurements of student knowledge about current agricultural topics and trends.

2. Illinois, one of the earliest state adopters of the Agriculture in the Classroom program has, at the time of this study, made advances toward aligning their agricultural literacy classroom materials, especially the Ag Mags, to meet the Common Core Standards and Next Generation Science Standards as adopted by the state.

A. The Minnesota Agriculture in the Classroom Program created an Ag Mag Jr for students in K-2, the only one of its kind in the nation at the writing of this study. Adoption, nationwide, of a publication such as this would create an opportunity for younger audiences to learn about the importance of agriculture in their daily lives with their families and siblings.

3. Students in this study demonstrated that they possessed some agricultural knowledge. However, the areas in which they had the least knowledge were Business and Economics; History, Geography and Culture; and Science, Technology and Environment.
Further research may be necessary to determine why students are deficient in these areas and provide suggestions to correct this deficiency.

A. Creating summer agricultural youth camps, similar to those held by 4-H, could expand students’ knowledge and interest about the field of agriculture.

4. Agricultural literacy may be viewed as unimportant, when in fact, the field of agriculture touches the lives of every man, woman, and child in ways many educators, parents, and students do not comprehend. As such, agricultural topics should receive greater recognition and adoption into current STEM or STEAM literacy programs.

5. Teachers from local area schools, who spoke with the researcher, stated that they would be more likely and more willing to incorporate agricultural literacy into their current school curriculums if grade-level appropriate materials aligned with the Common Core Standards and Next Generation Science Standards, including lesson plans, activities, and/or links to web-based materials, were available to them, preferably in a binder form with copy-ready lessons. Simply put, they indicated that they do not have time or adequate knowledge of the field of agriculture to search for or assemble appropriate materials while meeting the standards to which they are expected to instruct students.

6. A methodology and delivery system, such as one suggested by local teachers, should be developed that would infuse agricultural-based lessons into current curriculums.

Implications

Based on the findings of this study, the adoption and inclusion of agricultural literacy in elementary schools may be too narrow in scope. A review and expansion of agricultural education curriculums, programs, and currently available materials, Summer Ag Institutes for teachers, and cooperative extension programs and materials is needed. A
review of literature in this study found programs aimed at educating adults, not only in this
county, but also in other regions of the globe, which in the opinion of the researcher, is a
motivator to broaden efforts to educate the younger population on the importance
agriculture plays in their daily lives.

From the observations and interactions of the researcher with students and educators
who participated in the study, as well as those outside of the study, younger elementary
students, specifically K-1, more readily absorb and retain information, especially if
presented to them in an engaging approach. This may be a contributing factor as to why the
K-1 group scored higher on some themes than their 4-5 counterparts. On the other hand,
students, specifically 4-5 group, are often being “taught to the test”, i.e. standardized tests,
and have limited classroom time available to participate in activities and lessons not readily
seen as contributing to increasing test scores. School administrators, facing pressure at the
state and local levels, are focused on increasing school scores often to the detriment of
agricultural-based activities.

Additionally, as an analysis of the Solomon Four-Group design demonstrated pretest
sensitization, or test reactivity, did not drive the outcome of the study. The treatment,
agriculturally based lessons and activities, was the driving force of the outcome, i.e. the
posttest scores. Given this finding, school administrators may be more open to future
agricultural literacy testing if a posttest only is required.

With most Americans being three to four, or more, generations removed from their
farming roots, agricultural educators, industry, and university and extension educators may
aid the expansion of agricultural knowledge to other educators across other disciplines
resulting in broader adoptions of agriculture as a context for teaching other subject matter.
This may promote increased agricultural literacy starting with our youngest citizens, and over time, will spread agricultural literacy knowledge to the adult populace. Therefore, it is imperative that current and future student citizenry become agriculturally literate in order to lead, influence, and shape the future of agriculture and the world.

Agricultural literacy has been studied for over 30 years. During this period, programs, materials and curriculum have been designed to promote agricultural literacy, especially for K-8. New learning standards require agricultural literacy programs to evaluate and modify their methods, materials, and strategies to meet the changing need of educators and students alike.

Further dialogue among agricultural educators, agricultural literacy specialists, curriculum and instruction specialists, and STEM and STEAM educators is clearly needed to understand and address the societal necessity for understanding the importance of agricultural literacy.

“If we estimate dignity by immediate usefulness, agriculture is undoubtedly the first and noblest science.”

Samuel Johnson
LITERATURE CITED


Department for Environment, Food and Rural Affairs (Defra); Department of Health; Department for Children, Schools and Families (DCSF). (2007). *Year of Food and Farming 2007-2008, Evaluation Report*. Department for Environment, Food and Rural Affairs (Defra); Department of Health; Department for Children, Schools and Families (DCSF).


Leising, J. G., Pense, S. L., & Portillo, M. T. (2001). *The Impact of Selected Agriculture in the Classroom Teachers on Student Agricultural Literacy*. Oklahoma State University, Department of Agricultural Education, Communications, and 4-H Youth Development. Stillwater: United States Department of Agriculture.


APPENDICES
APPENDIX A

HUMAN SUBJECTS COMMITTEE APPROVAL FORM
To: Mary M. Fischer

From: Wayne R. Glass, CRA
    Interim Chair, Human Subjects Committee

Date: October 5, 2015

Subject: Comparative Assessment of Illinois Elementary Student Agricultural Literacy in Select Classrooms Employing Agriculture in the Classroom Methodologies

Protocol Number: 15281

The revisions to the referenced study have been reviewed and approved by the SIUC Human Subjects Committee.

This approval expires 9/2/2016, one (1) year from the review date. Regulations make no provision for any grace period extending beyond the above expiration date. Investigators must plan ahead if they anticipate the need to continue their research past this period. The application should be submitted 30 days prior to expiration with sufficient protocol summary and status report details, including number of accrued subjects and whether any withdrew due to complaint or injury. If you should continue your research without an approved extension, you would be in non-compliance of federal regulations. You would risk having your research halted and the loss of any data collected while HSC approval has lapsed. Extensions will not be required to continue work on an approved project when all the data has been collected, there will be no more interaction or intervention with human subjects and subject identifiers have been removed (e.g. during the data analysis or report writing stages).

Also note that any future modifications to your protocol must be submitted to the Committee for review and approval prior to their implementation.

Your Form A approval is enclosed. Best wishes for a successful study.

This institution has an Assurance on file with the USDHHS Office of Human Research Protection. The Assurance number is 00005334.

WG:kr

Cc: Seburn Pense
APPENDIX B

ADMINISTRATOR CONSENT FORM
I, ______________________, ______________________ (job title) of __________________ (school) am permitting researchers from Southern Illinois University access to our elementary students so that they may participate in a study titled, *Comparative Assessment of Illinois Elementary Student Agricultural Literacy in Selected Classrooms Employing Agriculture in the Classroom Methodologies*, conducted by Ms. Mary M. Fischer and Dr. Seburn L. Pense. This study is designed to assess agricultural literacy of Illinois elementary school students in grades K-6 in schools employing Agriculture in the Classroom methods.

I have reviewed the methodology of this study and understand that students will be asked to take written pre- and posttests.

I understand that student responses to the test questions will be kept confidential, and that the only persons who will see the individual test results will be Mary M. Fischer and Dr. Seburn L. Pense, who will report the results as group data only.

It is understood that participation is voluntary, and that there will be no risk to students participating in this study. *A parental permission form may be required for students to participate in this curriculum development program (please see enclosed form).*

Student assent will be obtained both orally and through written consent (see attached student consent form); a written script will explain the process of their taking the test, provide time for questions, and allow each student opportunity to decline participation without penalty.

_________________________  ____________
Signature                  Date
APPENDIX C

FOOD AND FIBER SYSTEMS LITERACY FRAMEWORK

THEMES AND STANDARDS
I. Understanding Food & Fiber Systems

Agriculture is the world’s oldest, largest, and most essential industry. Food and Fiber Systems, or agriculture, encompasses all the processes necessary to bring food and fiber products to the consumer, including production, processing, research, development, distribution, and marketing. Food and Fiber Systems provides people’s basic needs of food, clothing, shelter, and more.

Food and Fiber Systems is complex and far-reaching. About 20 percent of the United State’s labor force works in some part of the system. Globally, more people depend on agriculture for their livelihood than any other occupation. The growing world population will increase the demand for agricultural products, as well as qualified people to work in Food and Fiber Systems.

B. Understand the Essential Components of Food and Fiber Systems (e.g. production, processing, marketing, distribution, research and development, natural resource management, and regulation).

Food and Fiber Systems utilizes a wide array of components to create food, clothing and shelter products. Often, those products require special inputs or components.
The essential components of Food and Fiber Systems include production, processing, marketing, distribution, research and development, regulation, support services, and natural resource management.

The journey a product takes from producer to consumer usually includes numerous steps. Although some agriculturalists market and distribute their own products, the process often involves many people. Each step adds value to the product.

Processing takes a raw product, or commodity, and changes it to make it more useful for the consumer. Most agricultural commodities, such as fresh fruit, beef, cotton, and timber are processed in some form.

The marketing and distribution components take the processed product to the consumer. This may include transportation, wholesale and retail sales, and advertising.

Research and development includes the efforts of scientists to improve Food and Fiber Systems products. To meet the needs of a growing world population and generally increase the efficiency of the system, governments, private companies, and universities conduct agricultural research.

C. Understand Food and Fiber Systems’ Relationship to Society.

When people think of agriculture, often they have the limited understanding that agriculture only affects individuals through food, clothing and shelter. However, many of the products people use daily, directly or indirectly, come from Food and Fiber Systems. Plants and animals, especially, yield numerous by-products in addition to the primary product.

Today, the majority of the world’s people still directly work with the land. In developed countries like the United States, less than two percent of the population is involved in agricultural production. Instead, many people work in non-production aspects of Food and Fiber Systems, including processing, marketing, distribution, research and development, natural resource management, and regulation.

Agricultural production exists...
state is characterized by the agricultural commodities produced there.

The American agriculture system is one of the most efficient in the world. U.S. citizens spend the smallest proportion of income on food. Approximately 35 cents of each food dollar pays the actual production cost.

The ability to provide for future generations concerns many people today, and many agriculturists have made improvements towards a more sustainable agriculture system. Over time, human ingenuity has solved numerous problems of food production, storage, and preparation.

Throughout history, agricultural

D. Understand the Local, National, & International Importance of Food & Fiber Systems.

Agribusiness includes many enterprises associated with Food and Fiber Systems. These include brokers, processors, distributors, suppliers, and service providers such as consultants and financiers. The term agribusiness includes all industries that supply food and fiber products and

All over the world, Food and Fiber Systems shares resources with other industries, house- holds, and wildlife. Those include natural and human resources. Often, multiple uses allow scarce resources to be adapted for mutual benefit.

Early U.S. settlers brought food and fiber products from other countries. They also encountered plants and animals native to the New World. Some of those new products were traded and sent back to the colonist's native homeland. Expanding settlements and diverse cultures brought about demand for a greater variety of food and fiber products.

In America, the success of modern agriculture allows the U.S. economy the freedom to diversify and develop many other industries. Agricultural products still are the largest single U.S. export, and agriculture continues to be the largest industry.

In America, the success of modern agriculture allows the U.S. economy the freedom to diversify and develop many other industries. Agricultural products still are the largest single U.S. export, and agriculture continues to be the largest industry.

Agriculture is an integral part of almost every economy, providing employment and raw materials for people’s basic needs. Agriculture is the primary economic activity in many parts of the world, including America. In particular, rural areas are heavily dependent on agriculture. Weather changes,
Fiber Systems in this country must understand the global market forces that determine demand for their products.

E. Understand Food and Fiber Systems Careers.

Approximately 20 million Food and Fiber Systems jobs exist in the United States. About 50 percent of the jobs are in wholesale and retail trade of agricultural products, and many are in metropolitan areas. Processing, marketing, and distribution account for 30 percent of all agricultural jobs, while the remaining 20 percent are in production.

Today, Food and Fiber Systems is America’s largest industry. More than 20 percent of America’s workforce is employed in some phase of the agricultural industry. Seven people work in agribusiness for every farmer. In fact, more than 8,000 agricultural job titles exist.

Continued growth in world population means a greater demand for food and fiber. It also means a growing demand for qualified people in the agricultural industry. Almost high school is required for most positions. The demand for graduates in agricultural business and management, engineering, food science, sales, marketing, education and communications dramatically has expanded in recent years.

II. History, Geography, and Culture

Food and Fiber Systems played a key role in developing and sustaining every civilization. Agriculture has been the work of most of humanity through the ages. Agricultural themes can enhance the study of any period of history, from ancient civilizations and cultures to the westward movement and contemporary social issues.

The entire globe is open to scrutiny through agriculture and many important historical figures, inventions, and events are related to agriculture. Cultural, physical, and political geography can be taught through Food and Fiber Systems studies worldwide.

A. Understand Food and Fiber Systems’ Role in the Evolution Of Civilizations.

Agricultural systems...
gathering before learning to work with plants and animals and to cultivate the land. Early agricultural practices facilitated the more complex societies.

People began to live in permanent settlements. Eventually, abundant agricultural production allowed people to pursue activities other than working the land for their livelihood.

Humans always have altered and affected the places where they have lived. Originally, people lived as hunter/gatherers in tribes and bands. The hunter/gatherers lived off the land, collecting and catching what was locally and seasonally available.

Hunter/gatherer cultures tended to be limited in population and technological development. As groups followed animal migration, they traveled across whole continents entering new territories and natural environments. The availability of food and shelter in the places they lived impacted the size of individual groups, tribes or clans.

Many hunter/gatherer cultures developed pre-agricultural practices in which they manipulated the environment to control or increase their kills.

Agricultural trade stimulated the development of measurement, accounting, and written communication.

About 20 percent of the U.S. labor force works in some part of the Food and Fiber System.

Agrarian societies, like the ones in Mesopotamia, expanded rapidly. The study of stars, moon, sun, and planets helped people schedule planting and harvesting. Cultivation practices enabled surplus food production.

With food stored, people could dedicate their time to other pursuits such as the arts, science, and culture. Surplus food and fiber products were traded using the barter system. Agricultural trade stimulated the development of measurement, accounting, and written communication.

B. Understand Food and Fiber Systems’ Role in Societies throughout World History.

Improvements in the ability to provide food, clothing, and shelter have been paralleled by improvements in the health and well being of people in the world. As a result, the world’s...
of societies has involved conflicts over crop and grazing lands as well as access to ports and trading routes. The permanence of societies has also been dependent on access to and stewardship of soil and water resources.

Agricultural production throughout the Mediterranean region became dominated by in-kind taxation exacted by the conquering Romans. Non-perishable products such as wheat, olive oil, wine, and timber were produced on a large scale and shipped long distances to support the city of Rome.

Eventually, soil erosion, deforestation, overgrazing, and conflicts between farmers and herdsmen dramatically reduced the productivity of agriculture within the Roman Empire. Hunger and social unrest destroyed the Roman political system, bringing the Dark Ages.

In many parts of the world, feudal societies emerged. Landowners or “lords” relied on slaves, serfs, or peasants to work the land. The workers relied on the lords for protection from raiding bands and robbers. Wars were fought over crop and grazing lands, as well as access to ports and

than the rough wool and linen people had been using for clothing. Also, spices helped preserve food and diversified the diet of Europeans in the Middle Ages. The desire for agricultural products, as well as precious gems and minerals, eventually led to exploration and conquest of the Americas.

Before the arrival of Europeans in the Americas, agriculture already was highly developed in Central and South America, although less so in North America. The Incas thrived in the West Andes Mountains with architecture and irrigation systems that rivaled those of ancient Rome and Egypt.

The Maya, Olmec, Toltec, and Aztecs living around the Valley of Mexico are considered the first to cultivate maize, or corn as we know it today.

Development of international trade between societies, cultures and nations led to industrialization. That industrialization, in turn, led to increased amounts of Food and Fiber Systems products and a higher standard of living for industrialized societies. Industrialization and international trade of agricultural products and services have led to alliances between nations and have created global societies where different cultures blend and co-exist.

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The permanence of societies depends on access to and stewardship of soil and water resources.
C. Understand Food and Fiber Systems’ Role in U.S. History.

The most agriculturally advanced native people in North America included the Iroquois, who established permanent territorial associations around agricultural settlements and the Shoshone, who practiced agriculture in an arid climate, mostly relying on maize as a staple crop.

Most early American settlers were farmers. Many came seeking land, and religious freedom. When European colonists arrived on the East Coast, they tried to keep the agricultural practices they used back home. Many times, these practices failed, and mass starvation occurred in the early years of colonization. Spaniards found the Mediterranean climate in the west very similar to Spain, thus many of their agricultural crops including olives, grapes, figs, and cattle readily adapted to the new land.

On many occasions, American Indians came to the aid of the colonists, teaching them about native plants used for food and medicine. The settlers also adapted clothing early leaders, including signers of the Declaration of Independence, were agriculturalists.

Other historical events also relate to Food and Fiber Systems. The Homestead Act encouraged increased expansion of settlements west of the Mississippi River. Agriculture continued to impact U.S. history through the 20th century.

The crash of the stock market forced people to return to the land as a means of survival. The Dust Bowl drought on the Great Plains caused people to abandon farms and ranches in search of work in cities. Some of the nations largest dam projects were undertaken to control flooding of prime agricultural land.

The labor demands of agriculture in the U.S. strongly affected immigration and migration patterns. Historically, U.S. agriculture has provided employment opportunities to immigrants from all over the world. Since the beginning of World War II, the farm population of the U.S. has been declining principally due to improved agricultural technology.
D. Understand the Relationship between Food and Fiber Systems and World Cultures.

Historically, climate and geography have determined the plants and animals that grew best in a region. As a result, distinct eating habits emerged for people living in different places on Earth. As cultures and societies developed, religions and other beliefs further guided people’s food choices. Food, language, dress, and the arts are characteristics that evolved in relation to specific cultures.

When people migrate, they bring their culture and diet. Immigrants brought some staples of the American diet to this country. The United States produces many food and fiber products introduced by immigrants. With increasing ethnic diversity, there are more opportunities for businesses catering to changing consumer tastes.

The U.S. blends culture and traditions of people from different geographic regions. U.S. food and fiber products reflect these differences.

As Americans develop tastes for foods from all over the

E. Understand How Different Viewpoints Impact Food and Fiber Systems.

Some people view agriculture as nothing more than farming or ranching. Often, a person’s background or even geographic origin forms contrasting viewpoints surrounding Food and Fiber Systems. Many social issues are related to agriculture. The U.S. has moved from a rural society to an urban society partly due to the loss of jobs in production agriculture and the increase of jobs in agricultural product processing, packaging, marketing, and distribution.

In addition to agricultural labor, society is concerned about issues such as land use policies, protection of the environment, pesticide use, food safety, and animal welfare to name a few. Other issues include the practice of food irradiation and the development of genetically engineered foodstuffs.

Some of the issues are local in

III. Science, Technology, and Environment

The environment and agriculture are closely linked.
pursuits since before recorded

history. Scientific and techno-logical knowledge make agriculture more productive. Countless innovations have helped solve problems related to all aspects of the food and fiber system.

Agricultural abundance has made possible an increase in population worldwide, but this increase has put more demands on the planet’s natural resource systems. Scientific observation and investigation have confirmed that ecosystems are delicately balanced and globally interrelated, and we can no longer independently manage agriculture and the environment.

The vitality of Food and Fiber Systems now, and in the future, depends on public understanding of this interdependence. The need to preserve the quality of shared resources, land, air, and water will make the work of those in the agricultural and environmental sciences more important in years to come.

A. Understand How Ecosystems Are Related To Food and Fiber Systems

Ecosystems include plants, animals, environmental, and generally determine ecosystem diversity.

Food and Fiber Systems depends on ecosystem management for sustaining and increasing production. The natural cycles of plants and animals intricately are related to agriculture. Other natural cycles, including water and soil, make the production of food and fiber products possible.

Humans have manipulated succession in ecosystems for centuries, not only for agricultural purposes, but for industrial and personal use as well. Left alone, those ecosystems eventually will regenerate.

Agriculture affects ecosystems in both positive and negative ways. Inputs required for agricultural production, such as fertilizers and pesticides, often come from outside the ecosystem. They increase production potential. Once introduced, chemicals may change the system’s natural balance.

Modern agriculture is energy intensive, requiring non-renewable fossil fuels in all parts of the food and fiber system. As with any industry, air, water, and soil pollution are produced as a result of the activities of the system.
environment. Landscape design and ornamental plants beautify homes and communities. Conservation and restoration efforts by agriculturists have re-created habitats for previously threatened species. Food and Fiber Systems designed to work with nature can even reverse damage to ecosystems from the effects of poor land management.

B. Understand Food and Fiber Systems' Dependence on Natural Resources.

Soil, water, sunlight, and air are the renewable natural resources necessary for agricultural production. However, agriculture relies on living things and biological processes to transform these basic materials into food and fiber products.

Food and Fiber Systems depend on plants, animals, and microorganisms. They range from the tiniest algae, bacteria, yeast, and fungi to edible plants, fiber plants, and trees, as well as insects, birds, fish, and even the largest of animals.

Living organisms use the resources, but also replenish natural resources. Plants improve air quality by energy, Food and Fiber Systems also depends on non-renewable fossil fuel energy resources. This energy is used, for example, in the production, packaging, and application of chemical fertilizers and pesticides, in the manufacturing and operation of farm machinery, and in the distribution of agricultural products.

Some nations have abundant natural resources and can develop strong agricultural systems. Nations without the right combination of natural resources must rely on others for food and fiber. Nations also compete for available resources and those resources are traded between countries. The U.S. trades and sells Food and Fiber Systems products to other nations. In return, those nations may trade or sell resources or other goods and services to the U.S.


Conservation is the control and management of resources for present and future use. Agriculturalists have long been aware of the need to conserve natural resources.
Agricultural inventions, such as the hay baler, have impacted every aspect of Food and Fiber Systems for years. Farming along the contour of hills or in terraces is an example of conservation technique that minimizes soil erosion.

Cover crops are grown to be plowed back into the soil to add organic matter. Cover crops also provide an alternative to leaving the ground bare for a season. The foliage keeps the topsoil from baking in the sun, and the roots hold soil in place when it rains.

Examples of other traditional conservation practices include crop rotation and the use of hedgerows. Farmers rotate the plants and animals they raise in one place to resist the development of disease-causing organisms. Hedgerows protect fields from the wind and provide habitats for beneficial species that help protect crops and livestock from pests and disease.

Some conservation practices, such as Integrated Pest Management, are relatively new. Dangerous inorganic conserving topsoil and water. Genetic engineering has the potential to increase plant resistance to disease.

Sophisticated drip irrigation devices tell a grower exactly when, where, and how much water to apply to avoid waste. Modern agriculture is once again looking to traditional conservation practices to preserve the quality of soil and water.

D. Understand Science and Technology's Role in Food and Fiber Systems.

Humans always have used technology in Food and Fiber Systems. The first technological advances were simple tools, such as sticks, for planting seeds or digging roots. More sophisticated developments, such as diverting irrigation water from rivers and selecting preferred seed and breeding stock, were critical to early agriculture.

Agricultural inventions came about through science and technology. Those inventions have impacted every aspect of Food and Fiber Systems. Some inventions, like McCormick’s reaper and Whitney’s cotton gin, improved production and processing capabilities. Others,
Technology to produce, process, and preserve agricultural products has been handed down through generations. Today, Food and Fiber Systems relies on technology in nearly every scientific field.

Examples of the application of science to real-world problems are found in each component of the food and fiber system. One of the most important technologies to change agriculture was the introduction of the internal combustion engine.

Machines effectively have replaced human and animal power in most aspects of Food and Fiber Systems. Fewer people are needed to do the manual labor agriculture once required. However, increasing numbers of people are needed to support new agricultural technologies.

For example, in the area of breeding and selection, scientists continually are working to develop improved plant varieties that are more nutritious and resistant to pests and diseases. Genetic engineering is revolutionizing this area of agriculture.

Many other aspects of agriculture have benefited from technology. Milk production, storage, and processing depend on microbiology. Plant Pathology research has revealed the role of insects in disease transmission.

Revenues generated from Food and Fiber Systems businesses account for close to 20 percent of the annual U.S. gross national product.

IV. Business and Economics

Agribusinesses engage in the production, processing, marketing, or distribution of agricultural products, or in supplying agricultural inputs. Agribusinesses may furnish capital, machinery, equipment, chemicals, and supplies, as well as managerial and technical services. Revenues generated from Food and Fiber Systems businesses account for close to 20 percent of the annual U.S. gross national product.
Economics involves managing the income and resources of a household, community, or government.

Agriculture and economics are interdependent. Throughout history, the development of cultures and economies has been based on agricultural practices. The economy of any household, community, or government depends on meeting the food, clothing and shelter needs of the population.

Trade opportunities arise when product surpluses or shortages occur. For example, extreme weather may cause a shortage of a commodity in a state or region.

Surplus production of the commodity in another region usually can meet the demand for the product. International marketing stabilizes the supply/demand fluctuations for most food and fiber products.

Natural, political, and societal events impact food and fiber trade. Weather that negatively impacts production influences prices of consumer goods. Elections and other changes in governments affect nations’ economies and the global marketing of products and services. Changes in the economy of any household, community, or government often are linked to the nation’s and the world’s economies.

Natural, political, and societal events impact food and fiber trade.

Food and Fiber Systems represent a continuum extending from farms to factories, markets, and tables in every part of the world.

B. Understand Food and Fiber Systems Have An Impact On Local, National, and Global Systems.
directly to consumers in places like local farmers’ markets. However, most agricultural products are processed, packaged, and shipped long distances before reaching consumers.

There are large, international businesses that deal in food and fiber products. There are also smaller agribusinesses that rely on agriculture. Feed, seed and fertilizer dealers, implement dealers and equipment repair businesses rely on agricultural producers. The cardboard or plastic packaging manufacturer, restaurant owner, florist, and grocery store clerk also depend on Food and Fiber Systems for their livelihood.

Each step from production to consumption adds value to agricultural products. For example, what the producer sells for one dollar is processed and re-sold for more than one dollar.

Packaging, transportation and advertising also add to the consumer cost of the product. The difference in the product price from the producer’s sale to the consumer’s purchase can more than double the final price.

exports are the number one income source for the U.S.

C. Understand Government’s Role in Food and Fiber Systems.

Government regulations exist to ensure an abundant and affordable food supply and to protect farmers, consumers, the environment, and the economy. Governments work to ensure that the market system operates without impediment to provide stability to the market structure. Tariffs and trade agreements between nations are measures used to provide that stability.

Some of the governmental functions regulating agriculture in this country include safety, inspection, and grading. There are regulations to protect the safety of agricultural workers. There are also safety regulations to protect human and animal foodstuffs. The United States Department of Agriculture and the Environmental Protection Agency are but two of the government entities performing agricultural inspections.

All meat and many other foods are inspected by the United States Department of Agriculture. The Environmental Protection

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Government regulations exist to ensure an abundant and affordable food supply and to protect farmers, consumers, the economy.
Governments regulate trade through import duties and tariffs and create policies to manage the distribution of resources, such as water.

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International Food and Fiber Systems issues sometimes require government intervention. Some agricultural products grown in other countries cannot be sold in the U.S. because they do not meet governmental standards or may carry parasites or disease that could damage U.S. agricultural products. The U.S. government regulates the use of illegal immigrant farm laborers in an attempt to prevent the exploitation of those individuals.

Government policies impacting agriculture are partly the result of political action by groups or individuals. People facing common problems band together to influence elected officials to help solve those problems. In some instances, issues are taken directly to the voters. Organizations, often with competing interests, advocate legislation favoring particular industries and commodities. The political process provides a means for settling differences about resource management and agricultural activities.

Trade. The import and export of food and fiber commodities are concerns of foreign policy makers. In parts of the world, land ownership, technology, and the education level of farmers limit what is grown. Additionally, currency exchange rates and world markets influence international trade choices.

Historically, nations have protected markets, thereby limiting international trade. The U.S. is establishing open trade policies with nations limiting or heavily taxing imports. The North American Free Trade Agreement, the World Trade Agreement the General Agreement on Trade and Tariffs, and other trade agreements work to minimize or eliminate taxes on food and fiber products.

International supply and demand affects the types and quantities of products produced and traded worldwide. Wars, political unrest, and related issues influence a nation’s ability to produce surpluses for international trade. Adequate infrastructures, such as transportation and distribution systems, are required to successfully export and import products.
Numerous agricultural services are traded or sold between nations. Education, technology and consultation are a few examples of services traded among nations. Often, Food and Fiber Systems products or services are traded for industrial, or even military, products and services.

Increasing world population, food choices and economic prosperity are providing an expanding international market for affordable agricultural commodities. U.S. Food and Fiber Systems production is far ahead of the nation’s consumption. With additional free trade.

V. Food, Nutrition, and Health

Food and Fiber Systems provides the abundant and affordable food supply needed for survival, growth, and health. Nutrition, food, and agriculture are inseparable. Knowledge of nutrition and health increasingly are important due to abundant food choices.

A. Understand Food & Fiber Systems Provide Nourishment for People and Animals

People and animals depend on Food and Fiber Systems for product, but are differently processed to be appealing and palatable to animals or people.

Most human foods are processed in some way. Many animal feeds are also processed. Processing adds flavor, increases digestibility, and makes food products more convenient. Processing also allows foodstuffs to be stored for long periods without spoiling or losing nutritive value.

Often, processing changes the raw product in such a way that it is unrecognizable. Corn syrup is used as sweetener in candy and confections. Grain and hay for animal feed may be ground and pelleted. The law requires processed foods to have an ingredient label attached.

Food and feed products may

B. Understand Food and Fiber Systems Provide Healthy-Diet Components

Healthful eating means eating a variety of nutritious foods. Food contains six nutrients that people need for good health. These nutrients include carbohydrates, proteins, fats, minerals, vitamins, and water.
Food Guide Pyramid suggests daily food servings. The Pyramid is made up of six sections, each containing foods of similar origin or nutrient value. When planning healthy meals, it is important to recognize the serving sizes according to the Food Guide Pyramid. The major food groups, their primary nutrients, and the number of recommended daily servings are important to a healthy diet.

Fats and sweets are not considered part of the major food groups and should be eaten in limited quantities. Some fats provide essential fatty acids, which are necessary for proper body function. However, foods primarily made of sugar or fat are considered empty calories because they provide little or no nutrition. Processed foods, in comparison to fresh foods, generally have more fat, sugar, and salt. Processed foods also may have preservatives added to extend shelf life.

An ideal diet, according to the Food Guide Pyramid, should provide all the essential nutrients for life stages, including, growth, maintenance, reproduction, and lactation. Exercise and activity balance one another.

C. Understand Food and Fiber Systems Provides Food Choices

Food and Fiber Systems provides a variety of year-round food choices. Foods not locally produced are available, partly due to the transportation and distribution networks.

Many factors influence food choices. One factor in food choice is cost. Generally, staple foods are less expensive; pre-pared foods are more costly.

Individual preferences are important in food selection. Many of these are based on habits, largely determined by cultural backgrounds. More Americans are purchasing food that is convenient to prepare because they choose to spend time on activities other than food preparation.

In addition to these fundamental factors, food choices are influenced by information that shapes opinions about food. Scientific research has revealed much about the nutritive proper-ties of foods, as well as human requirements for nutrients. According to health professionals, eating well and exercising...
The food industry tests and develops new varieties of foods and food-processing methods, and sponsors research to examine the health benefits of specific foods. The food industry works with health professionals and government agencies to ensure that nutritional benefits of foods accurately are represented.

Food safety is a growing concern among consumers. Agriculturists have worked to address food safety concerns through new management methods, technology, and the media. New technologies such as food irradiation and biologically engineered food products must be explained to consumers and safety concerns addressed if the technology is to be accepted.

The U.S. food supply is considered the safest in the world. Still, food safety issues do exist here and elsewhere. According to food safety experts, improper storage, handling, and preparation of food, both at home and at food establishments, poses the number one food safety problem today. Consumers who habits or demand better regulations of food production practices. Together, food producers, consumer groups, and government agencies work to develop food safety and nutrition guidelines and regulations.

There are numerous food contaminants. Some, like insects, bacteria, and fungi, are living. Others, such as bone fragments or chemical residue are non-living. Contamination may occur during any step of food processing. Government policy and inspection guard against food contamination.

The USDA revised food-labeling laws so nutrition information on packaged foods is more complete and uniform to help consumers make healthier food choices.
APPENDIX D

FOOD AND FIBER SYSTEMS FRAMEWORK

STANDARDS AND BENCHMARKS
Benchmarks
## 1. Understanding Food and Fiber Systems

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>A. Understand the meaning of Food and Fiber Systems/agriculture.</th>
<th>B. Understand the essential components of Food and Fiber Systems (e.g. production, processing, marketing, distribution, research and development, natural resource management, etc.)</th>
<th>C. Understand Food and Fiber Systems' real-township to society.</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-1</td>
<td>Student will discover food, clothing, and shelter originate from plants and animals. They will match and/or illustrate a product.</td>
<td>Students will identify types of farms. They will match different kinds of farms to their products.</td>
<td>Students will identify Food and Fiber Systems products. They will explain the role of natural resource management in Food and Fiber Systems. They will explain the importance of managing soil, air, water, and energy to agricultural production.</td>
</tr>
<tr>
<td>2-3</td>
<td>Student will tell how agriculture provides people's basic food, clothing, and shelter needs. They will identify regional contributions to world agricultural production.</td>
<td>Students will describe the journey of an agricultural product from the farm to the consumer. They will label the sequence of steps a food or fiber product takes from its production to the consumer.</td>
<td>Students will identify major agricultural commodities produced in their state. They will compare commodity output at national levels.</td>
</tr>
<tr>
<td>4-5</td>
<td>Students will identify the natural resources Food and Fiber Systems use to provide people's basic needs. They will describe how resources (rivers, forests, oceans, range land, etc.) contribute to world agricultural production.</td>
<td>Students will describe the function of Food and Fiber System component(s), including production, processing, marketing, distribution, research and development, natural resource management, and regulation. They will define the function of each component.</td>
<td>Students will identify the role of natural resource management in Food and Fiber Systems. They will explain the importance of managing soil, air, water, and energy to agricultural production.</td>
</tr>
<tr>
<td>6-8</td>
<td>Students will define agriculture in terms of the Food and Fiber System components. They will show agriculture is a complex system of production, processing, marketing, distribution, research and development, natural resource management, and regulation. They will discuss the function of each component.</td>
<td>Students will explain the importance of the essential components of Food and Fiber Systems and describe their interdependence. They will discuss how the components have changed.</td>
<td>Students will identify plant and animal products that serve as ingredients for producing products that meet societal needs. They will explain how things and products are used.</td>
</tr>
<tr>
<td>9-12</td>
<td>Students will explain why agriculture is the foundation of a nation's standard of living. They will demonstrate that Food and Fiber Systems must be sustainable, and resources used must be renewed and replenished.</td>
<td>Students will explain the importance of the essential components of Food and Fiber Systems and describe their interdependence. They will discuss how the components have changed.</td>
<td>Students will identify plant and animal products and byproducts used to...</td>
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<tr>
<td>Standards</td>
<td>Benchmarks</td>
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<tr>
<td>D. Understand the local, national, and international importance of Food and Fiber Systems.</td>
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<tr>
<td>Students will identify local Food and Fiber Systems businesses. They will match these businesses to</td>
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<tr>
<td>Students will determine resources, such as water and land, are shared by households, businesses, and agriculture. They will describe examples of multiple</td>
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<tr>
<td>Students will examine why agriculture is the oldest, largest, and most-essential industry. They will discuss the national and international importance of Food and Fiber Systems.</td>
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<tr>
<td>Students will explain how globalization has impacted commodities traded on world markets. They will cite examples of how global markets affect personal and professional choices.</td>
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</tr>
<tr>
<td>E. Understand Food and Fiber Systems careers.</td>
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</tr>
<tr>
<td>Students will identify Food and Fiber Systems jobs in the community. They will collect pictures of people doing agricultural</td>
<td>K-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students will generate a list of Food and Fiber Systems careers. They will research characteristics of agricultural careers.</td>
<td>2-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students will examine the changes in Food and Fiber Systems due to technological advances, and subsequent changes in occupational opportunities. They will identify agricultural careers and how they have changed.</td>
<td>4-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students will recognize that agricultural inventions and discoveries produce new career opportunities. They will compare knowledge, skill, and attitudes required for entry-level, technical, and professional careers in Food</td>
<td>6-8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students will discuss non-traditional agricultural careers and their effects on other industries. They will create a career path and determine its relationship to Food and Fiber Systems.</td>
<td>9-12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### II. History, Geography, and Culture

<table>
<thead>
<tr>
<th>Standards</th>
<th>A. Understand Food and Fiber Systems' role in the evolution of civilizations.</th>
<th>B. Understand Food and Fiber System's role in societies throughout world history.</th>
<th>C. Understand Food and Fiber Systems' role in U.S. history.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>K-1</strong></td>
<td>Students will illustrate how agriculture provides food, clothing, and shelter. They will classify agricultural products as food, clothing, or shelter.</td>
<td>Students will illustrate how events, such as seasonal festivals, focus on Food and Fiber Systems. They will identify agriculture-based traditions or celebrations in the region.</td>
<td>Students will realize most early agricultural sites were located near water sources.</td>
</tr>
<tr>
<td><strong>2-3</strong></td>
<td>Students will explain how agriculture is the foundation of civilizations. They will identify family experiences or involvement with Food and Fiber Systems.</td>
<td>Students will identify an early society. They will illustrate agriculture's role in sustaining that society.</td>
<td>Students will describe how native and settler populations interacted with the environment.</td>
</tr>
<tr>
<td><strong>4-5</strong></td>
<td>Students will analyze how early inhabitants mostly relied on hunting and gathering. They will describe agricultural changes from nomadic societies to permanent settlements.</td>
<td>Students will discuss the desire to obtain exotic foods and spices, and precious gems and minerals motivated European exploration. They will trace the origins of food, fiber, and natural resources early European explorers traded.</td>
<td>Students will illustrate how people living in regions moved from region to region to meet their basic needs.</td>
</tr>
<tr>
<td><strong>6-8</strong></td>
<td>Students will determine agriculture's role in the development of civilizations. They will evaluate innovations that increased the availability of food, clothing, and shelter.</td>
<td>Students will explain how expanded trade led to development of industrialized societies. They will evaluate the importance of agricultural contributions in the growth of international trade.</td>
<td>Students will identify historical events that influenced agricultural practices. They will describe positive and negative impacts on food and fiber systems.</td>
</tr>
<tr>
<td><strong>9-12</strong></td>
<td>Students will compare nomadic life to settlements and towns. They will analyze how the barter system evolved and encouraged economic growth.</td>
<td>Students will identify nations where international food and fiber involvement exists. They will investigate the impact of global societies on food and fiber systems.</td>
<td>Students will identify the role agriculture played in U.S. development. They will analyze agriculture's role in events that shape the nation.</td>
</tr>
</tbody>
</table>

A Guide to Food and Fiber Systems
<table>
<thead>
<tr>
<th>Standards</th>
<th>Benchmarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. Understand the relationship between Food and Fiber Systems and world cultures.</td>
<td></td>
</tr>
<tr>
<td>Students will discover foods they consume originated from different countries. They will trace foods back to the original country.</td>
<td></td>
</tr>
<tr>
<td>E. Understand how different viewpoints impact Food and Fiber Systems.</td>
<td></td>
</tr>
<tr>
<td>Students will realize people live in cities, towns, and rural areas. They will illustrate characteristics of cities, towns, and rural areas.</td>
<td>K-1</td>
</tr>
<tr>
<td>Students will explain why agriculture influences food and clothing in cultures. They will compare food and clothing among cultures.</td>
<td>2-3</td>
</tr>
<tr>
<td>Students will determine whether they live in a city, suburb, town, or rural area. They will give examples of contrasting views of Food and Fiber Systems in the community.</td>
<td>4-5</td>
</tr>
<tr>
<td>Students will identify geographic origins of plants and animals. They will locate current world-production areas of Food and Fiber Systems products.</td>
<td></td>
</tr>
<tr>
<td>Students will identify Food and Fiber Systems issues in the community or state. They will contrast different viewpoints of each issue.</td>
<td>6-8</td>
</tr>
<tr>
<td>Students will explain how geography influences food and fiber production. They will analyze regional geographic characteristics influencing food, clothing, and shelter choices.</td>
<td></td>
</tr>
<tr>
<td>Students will summarize national Food and Fiber Systems issues. They will analyze the viewpoints of major stakeholders.</td>
<td>9-12</td>
</tr>
<tr>
<td>Students will recognize world cultures affect agriculture. They will explain how consumer trends impact Food and Fiber Systems.</td>
<td></td>
</tr>
<tr>
<td>Students will compare global issues impacting Food and Fiber Systems. They will justify personal viewpoints based on research.</td>
<td></td>
</tr>
</tbody>
</table>
## Standards

<table>
<thead>
<tr>
<th>D. UNDERSTAND THE RELATIONSHIP BETWEEN FOOD AND FIBER CULTURES.</th>
<th>E. UNDERSTAND HOW DIFFERENT VIEWPOINTS IMPACT FOOD AND FIBER SYSTEMS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will realize people live in cities, towns, and rural areas. They will illustrate characteristics of cities, towns, and rural areas.</td>
<td>Students will determine whether they live in a city, suburb, town, or rural area. They will give examples of contrasting views of Food and Fiber Systems in the community.</td>
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<tr>
<td>Students will explain why agriculture influences food and clothing in cultures. They will compare food and clothing among cultures.</td>
<td>Students will identify Food and Fiber Systems issues in the community or state. They will contrast different viewpoints of each issue.</td>
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<td>Students will identify geographic origins of plants and animals. They will locate current world-production areas of Food and Fiber Systems production.</td>
<td>Students will summarize national Food and Fiber Systems issues. They will analyze the viewpoints of major stakeholders.</td>
</tr>
<tr>
<td>Students will explain how geography influences food and fiber production. They will analyze regional geographic characteristics influencing food, clothing, and shelter choices.</td>
<td>Students will compare global issues impacting Food and Fiber Systems. They will justify personal viewpoints based on research.</td>
</tr>
</tbody>
</table>

### Benchmarks

- **K-1**
  - Students will identify geographic origins of plants and animals. They will locate current world-production areas of Food and Fiber Systems production.
  - Students will explain why agriculture influences food and clothing in cultures. They will compare food and clothing among cultures.

- **2-3**
  - Students will determine whether they live in a city, suburb, town, or rural area. They will give examples of contrasting views of Food and Fiber Systems in the community.

- **4-5**
  - Students will identify Food and Fiber Systems issues in the community or state. They will contrast different viewpoints of each issue.

- **6-8**
  - Students will summarize national Food and Fiber Systems issues. They will analyze the viewpoints of major stakeholders.

- **9-12**
  - Students will compare global issues impacting Food and Fiber Systems. They will justify personal viewpoints based on research.

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*A Guide to Food and Fiber Systems*
## III. Science, Technology, and Environment

### Standards

<table>
<thead>
<tr>
<th>Benchmarks</th>
<th>A. Understand how ecosystems are related to Food and Fiber Systems.</th>
<th>B. Understand Food and Fiber Systems dependence on natural resources.</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-1</td>
<td>Students will identify the natural life cycles of plants and animals. They will illustrate life-cycle stages.</td>
<td>Student will identify natural resources used by Food and Fiber Systems. They will illustrate natural resources.</td>
</tr>
<tr>
<td>2-3</td>
<td>Students will describe components of an ecosystem. They will illustrate specific components of an ecosystem in the community.</td>
<td>Students will describe renewable and non-renewable natural resources used in Food and Fiber Systems. They will identify natural resources.</td>
</tr>
<tr>
<td>4-5</td>
<td>Students will discover ecosystems regenerate. They will analyze the interaction of Food and Fiber Systems with natural cycles.</td>
<td>Students will examine how living organisms transform natural resources into usable products. They will identify the roles of these organisms in agriculture.</td>
</tr>
<tr>
<td>6-8</td>
<td>Students will discover similarities of ecosystems in the world. They will categorize ecosystems by common characteristics (e.g., topography, climate, soil type and other factors).</td>
<td>Students will identify classes of organisms involved in Food and Fiber Systems. They will explain the roles of these organisms in agriculture.</td>
</tr>
<tr>
<td>9-12</td>
<td>Students will identify how Food and Fiber Systems affect ecosystems. They will evaluate the positive and negative impact of agriculture on ecosystems.</td>
<td>Students will explain why all countries' agricultural systems depend on natural resources. They will evaluate why Food and Fiber Systems compete for natural resources.</td>
</tr>
<tr>
<td>Standards</td>
<td>Benchmarks</td>
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<tr>
<td><strong>C. Understand management and conservation practices used in Food and Fiber Systems.</strong></td>
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<tr>
<td>Student will define natural resource conservation. They will describe ways to conserve natural resources.</td>
<td>K-1</td>
<td></td>
</tr>
<tr>
<td>Students will identify natural resource-management practices that limit pollution. They will cite agricultural practices used to manage and conserve soil, water, and air.</td>
<td>2-3</td>
<td></td>
</tr>
<tr>
<td>Students will identify pest-management practices in Food and Fiber Systems. They will compare traditional and alternative pest-management practices.</td>
<td>4-5</td>
<td></td>
</tr>
<tr>
<td>Students will identify agencies and policies that regulate natural resource-management and conservation of Food and Fiber Systems. They will determine the impact these practices have on the natural environment.</td>
<td>6-8</td>
<td></td>
</tr>
<tr>
<td>Students will recognize U.S. management and conservation practices impact other countries. They will evaluate the impact of these practices on Food and Fiber Systems in other countries.</td>
<td>9-12</td>
<td></td>
</tr>
<tr>
<td><strong>D. Understand science and technology's role in Food and Fiber Systems.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students will identify tools and machines used in Food and Fiber Systems. They will give examples of tools and machines used to produce food and fiber products.</td>
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<td></td>
</tr>
<tr>
<td>Students will recognize inventor and their inventions related to Food and Fiber Systems. They will describe the agricultural importance of the technology.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students will explain how technological advancement enhance Food and Fiber Systems' efficiency. They will list technologies that reduce manual labor needs in agriculture.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students will identify Food and Fiber Systems careers dependent on science and technology skills. They will contrast these skills needed for agricultural and non-agricultural careers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students will recognize how science and technology impact Food and Fiber Systems. They will analyze the effects of science and technology on food, clothing, shelter, and career choices.</td>
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</tbody>
</table>
### IV. Business and Economics

<table>
<thead>
<tr>
<th>Benchmarks</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>A. Understand Food and Fiber Systems and economics are related.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>B. Understand Food and Fiber Systems have an impact on local, national, and international economies.</strong></td>
</tr>
<tr>
<td><strong>K-2</strong></td>
<td>Students will recognize agricultural products have monetary value. They will explain how food and clothing are worth money.</td>
</tr>
<tr>
<td></td>
<td>Students will identify people in the community who rely on Food Fiber Systems to make a living. They will compare jobs performed in production to consumption.</td>
</tr>
<tr>
<td><strong>4-5</strong></td>
<td>Students will define agribusiness. They will give examples of agribusinesses in the community.</td>
</tr>
<tr>
<td></td>
<td>Students will identify how value is added to raw agricultural products after production. They will compare the value of raw and processed products.</td>
</tr>
<tr>
<td><strong>6-8</strong></td>
<td>Students will identify Food and Fiber Systems-related careers. They will compare business and economic skills and educational qualifications for agricultural careers.</td>
</tr>
<tr>
<td></td>
<td>Students will identify industries whose inputs are from Food and Fiber Systems. They will evaluate industries to determine the agricultural inputs.</td>
</tr>
<tr>
<td><strong>9-12</strong></td>
<td>Students will identify events affecting food and fiber trade. They will analyze the economic impact of these events on Food and Fiber Systems.</td>
</tr>
<tr>
<td></td>
<td>Students will identify economic activities generated by Food and Fiber Systems. They will compare how agricultural and non-agricultural businesses influence the economy.</td>
</tr>
<tr>
<td>C. Understand government’s role in Food and Fiber Systems.</td>
<td>D. Understand factors influencing international trade of food and fiber products.</td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Not applicable at this level.</td>
<td>Students will recognize food and clothing comes from other countries. They will give examples of food and fiber products from.</td>
</tr>
<tr>
<td>Students will recognize the government regulates Food and Fiber Systems. They will classify government functions, including safety, inspection, and regulation.</td>
<td>Students will define import and export. They will identify U.S. food and fiber products exported to other countries.</td>
</tr>
<tr>
<td>Students will explain the need for government regulation in agriculture. They will give examples of regulations and laws impacting Food and Fiber Systems.</td>
<td>Students will explain why nations trade products and services. They will make a list of agricultural services the U.S. trades with other nations.</td>
</tr>
<tr>
<td>Students will recognize the government responds to people’s needs related to Food and Fiber Systems.</td>
<td>Students will explain “free trade” and “balance of trade.” They will compare U.S. food and fiber trade policies to other nations’ policies.</td>
</tr>
<tr>
<td>Students will identify international Food and Fiber Systems issues. They will analyze governments’ roles in international agricultural issues.</td>
<td>Students will identify factors influencing international trade. They will explain how these factors impact U.S. food and fiber products and services.</td>
</tr>
</tbody>
</table>
### V. Food, Nutrition, and Health

<table>
<thead>
<tr>
<th>Standards</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Understand Food and Fiber Systems provide nourishment for</strong></td>
<td><strong>B. Understand Food and Fiber Systems provide healthy-diet components.</strong></td>
</tr>
<tr>
<td><strong>Benchmarks</strong></td>
<td><strong>Benchmarks</strong></td>
</tr>
<tr>
<td>K-1 Students will explain people and animals obtain sustenance from Food and Fiber Systems products. They will illustrate products people and animals.</td>
<td>Students will identify the parts of the Food Guide Pyramid. They will illustrate a well-balanced meal.</td>
</tr>
<tr>
<td>2-3 Students will distinguish between processed and unprocessed foodstuffs people and animals eat. They will compare how common foodstuffs eaten by humans and animals are differently.</td>
<td>Students will match food groups with their recommended daily servings. They will plan healthy meals for one day.</td>
</tr>
<tr>
<td>4-5 Students will identify ways of processing foodstuffs for people and animals. They will explain reasons for processing foodstuffs.</td>
<td>Students will identify the six basic food nutrients: carbohydrates, protein, water, vitamins, minerals, and fats. They will categorize foods based on nutritional content.</td>
</tr>
<tr>
<td>6-8 Students will identify agricultural products in food and feed. They will compare food and feed ingredient labels.</td>
<td>Students will interpret food nutritional labels. They will recognize personal food intake to the USDA Food Guide.</td>
</tr>
<tr>
<td>9-12 Students will recognize that food and feed products contain additives. They will categorize additives from ingredient labels.</td>
<td>Students will recognize life stages and activity levels change human nutrition requirements. They will construct healthy diet and exercise plans for different life stages and activity levels.</td>
</tr>
<tr>
<td>Standards</td>
<td>Benchmarks</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td><strong>C. Understand Food and Fiber Systems provide food choices.</strong></td>
<td></td>
</tr>
<tr>
<td>Students will recognize how individual preferences affect food selection. They will show where their food preferences fit into the Food Guide.</td>
<td>K-1</td>
</tr>
<tr>
<td><strong>D. Understand Food and Fiber Systems promote a safe food supply.</strong></td>
<td></td>
</tr>
<tr>
<td>Students will recognize safe food practices. They will illustrate ways to practice food safety.</td>
<td></td>
</tr>
<tr>
<td>Students will identify food advertisements. They will explain the relationship between food choice and advertising.</td>
<td>2-3</td>
</tr>
<tr>
<td>Students will describe how research and development influences food choices. They will research new food choices.</td>
<td></td>
</tr>
<tr>
<td>Students will recognize the government makes food safety policies. They will explain how these policies promote a safe food supply.</td>
<td>4-5</td>
</tr>
<tr>
<td>Students will recognize food contaminants. They will classify the contaminants that make food unsafe.</td>
<td>6-8</td>
</tr>
<tr>
<td>Students will recognize factors affecting a safe food supply. They will evaluate how food safety issues impact Food and Fiber Systems.</td>
<td>9-12</td>
</tr>
</tbody>
</table>
APPENDIX E

FOOD AND FIBER SYSTEMS LITERACY

K-5 TESTS
The accompanying tests were developed for evaluating student progress of Food and Fiber Systems knowledge, based on the Food and Fiber Systems Literacy Standards and Benchmarks. The questions on each instrument directly relate to the respective grade-group benchmarks. The corresponding standard and Assessment Process

We recommend the tests be given three times within the grade groups for which they are intended. A pre-test should be given to assess existing student knowledge of Food and Fiber Systems and to help the teacher in determining appropriate instruction to achieve the standards. Each test should be given again near the midpoint of the grade grouping as a formative evaluation and to determine needed remediation within the themes and standards. The third, or summative, administration should be near the end of the grade grouping to assess mastery of benchmarks within the grade grouping.

Example-K-1 Grade Grouping

Pretest — soon after beginning of Kindergarten year

During pilot testing we learned students are apprehensive about taking the pretest because it includes material they have not yet covered. It helps to assure students the pretest in no way affects their classroom grades. However, teachers may want to incorporate or tie the summative test results, especially, of

Teacher/Student
Teacher or student instructions, as appropriate, are printed on the cover page of each test

Who can use the test

The copyright holder grants permission to the purchaser of these evaluation instruments to duplicate the instruments as necessary for the express purpose of assessing student knowledge and achievement in Food and Fiber Systems literacy skills.
Literacy Tests

For Grades K-1, 2-3, 4-5, and 6-8

Carl G.lgo, James G.Leising, Martin J.Frick, Daniel Hubert and Alexander M.Malcolm

Food and Fiber Systems
Literacy
Department of Agricultural Education and
Communication
Food and Fiber Systems Literacy

Teacher Instructions: This instrument consists of 21 questions, incorporating words and picture recognition. Have your students follow along as you read each question, then assist the students in marking their response choices. If your students have trouble understanding the words or pictures, use your own discretion as to how much of the text they should understand.
1. Draw a line from each food to the plant or animal

- Chees
- Bacon
- Pecan
- Eggs
- Bread
- Tree
- Pig
- Dairy
- Wheat
- Chicken
2. Draw a line from the product in the first row to plant or animal it comes from in the row

wool  leather  denim  books

cotton  sheep  tree  cow

3. Draw a line from the product in the first row to the of farm it comes from in the row

milk  meat  hot dog

beef cattle  wheat  dairy farm
4. Draw a line from the business in the first row to the food and fiber product in the second row used by

- bakery
- florist
- home
- flower
- tree
- whea

5. Circle the pictures of people doing agricultural
6. Circle the agricultural product people use to make

- tree
- horse
- pumpkin

7. Circle one picture that represents a special day

- Easter
- Thanksgivin
- Valentine'
- Christmas
- St. Patrick's
- Independence
8. Draw a line connecting the Pilgrim to the way most

9. Circle the pictures showing foods that came different
10. **Draw red circles around the pictures of things you would find in a city**

- Windmill
- Freeway
- Museum
- Tractor

11. **Draw a red circle around the first thing that you do to grow a plant**

- Harvest
- Water
- Plant seeds
12. Circle the pictures of things plants must have to

- rain
- money
- electricity
- sunlight

13. Circle the pictures showing a way to conserve natural

- turn off
- pick up
- go
14. Draw a line from the food and fiber systems product to

- bread
- ice
- clothes
- sewing machine
- combine
- milking

15. Draw a line connecting the groceries to what you

- beads
- money
- cloth
16. Circle the pictures showing people who earn money

nurs  baker  mechani

17. Circle the pictures showing food and fiber

coffe  banana  milk
18. Draw a line from the girl to the foods people eat

pancakes
hay
stea
oats
popcor
19. Draw a line from the boy to the nutritious

![Image](image1)

20. Draw a line from the breakfast foods to where they fit

- Fish
- Candy
- Apple
- Donuts
- Milk
- Muffins
- Grapefruit
21. Connect the pictures in the first column to the second column to show ways you can practice hand

refrigerator

soap

oven

turkey

eggs

Oklahoma State University
Food and Fiber Systems Literacy

**Teacher Instructions:** This instrument consists of 21 questions incorporating both word and picture recognition. Have your students follow along as you read each question, then assist the students in correctly marking their...
1. Match the food and fiber product in the first column to

- Food
  - cattle

- Clothing
  - tree

- Shelter
  - lobster

- Food and Fiber Systems Literacy
  - vegetables and

- Oklahoma State University
  - fabric
2. Rank the items below in order (1-5) from the producer

D Processing

D Consumption

D Distribution

D Production

0Marketing

3. Connect the people pictures to the food and fiber

Food

Clothing

Shelte
4. Connect the natural resource to the way it is

- camping
- swimming
- medical
- irrigation
- land
- house
- mining
- boating
- water
- crops
5. Circle the pictures of people with food and fiber

Chef
Veterinaria
Police
Doctor
Auctioneer
Plant

6. Connect the planting practice with the correct

1 year ago
100 years
1000 years
7. Connect each nation's flag to the food or clothing from

- USA
- Germany
- Mexico
- Scotland
- China

- kilt
- hamburgue
- fortune
- lederhose
- tacos

© Food and Fiber Systems Literacy
8. Draw an arrow connecting the agricultural practice to the correct line under American Indians or Early American.

American

migrating with wildlife

oxen to pull farm implements--
clothing of cotton or

clothing of animal

fish to fertilize

relied on native plants and

brought new plants and

Early American

Rank the communities in order (1-4) from the largest to the smallest.

town

suburb

city
10. Circle the parts of an ecosystem.

- air
- wildlife
- tree
- factory
- pollution
- pets
- house

11. Classify the natural resources from the word bank as

<table>
<thead>
<tr>
<th>Renewable</th>
<th>Non</th>
</tr>
</thead>
<tbody>
<tr>
<td>crude oil</td>
<td></td>
</tr>
<tr>
<td>water</td>
<td></td>
</tr>
<tr>
<td>trees</td>
<td></td>
</tr>
<tr>
<td>coal</td>
<td></td>
</tr>
<tr>
<td>soil</td>
<td>sunlight</td>
</tr>
</tbody>
</table>
12. Circle the pictures showing natural
conservation

- turn off
- leave refrigerator door
- ride bicycles
- plant
- water
- recycle

13. Match the inventors with their

Eli Whitney  George Washington  John Deere

- peanut
- steel
- cotton gir
14. Circle the correct word to complete each

If wool clothing goes out of style there will be a _______ of wool shortage.

If a new use for chicken feathers is discovered there will be a _______ of feathers shortage.

If the wheat harvest is small because of drought there will be a _______ of wheat shortage.

If people eat less pork there will be a _______ of pork shortage.

15. Circle the things a farmer does to produce a

Put an X through the things the processor

- planting
- refining
- irrigating
- storing
- harvesting
- packaging
16. Circle the words describing roles of government in grading growing inspecting store

food safety selling

17. Circle the foods people

Put an X through the feeds animals

- celery
- oats
- soybean
- oat bran
- steak
18. Circle the food and fiber **products** the US

Put an X through the food and fiber products the US

- cocoa
- coffee
- corn
- soybean
- vanilla
- wheat

19. Match the recommended daily serving to the food

A. 2-3 servings per day
B. 6-11 servings per day

D. 2-4 servings per day
E. use sparingly

F

- Meat,
- Poultry, Fish, Dry Beans, Eggs

- Vegetable Group
- Fruit Group

- Bread, Cereal, rice,
20. Circle the products you see

Put an X through the products you don't see

writing  raisins  breakfast  milk

seafood  beef  grapes  okra

21. Connect the food to the way it is safely handled,

canned  always stored in
fresh milk  always wash before
ground  safely stored in
fresh  always cook to well-
Food and Fiber Systems Literacy

**Student Instructions:** The following pages contain 22 questions about Food and Fiber Systems. Please read each question carefully and choose the correct answer or answers. Use a pencil to mark all answers. If you decide to change an answer, carefully and completely erase the incorrect answer.
I. Circle five natural resources in the list

Rivers       Crops       Soil
Forest       Rangeland   Labor
Oceans       Machinery   Corn

II. Circle the four natural resources farmers

Soil        Rainfall    Temperatur    Air
Water       Energy      Coal         Rocks

III. Circle the answer with two of the most common agricultural commodities

Oats and Pigs          Wheat and
Rice and Chickens     Barley and

IV. From the list below, circle all the groups that brought agricultural products

Trader           Colonists
Explorers        American
5. Circle the job that is related to food and fiber

   Movie                     Grocery Clerk
   Minister                  Librarian

6. Nomadic societies relied on _________ and _________ for their food. (Circle the correct answer)

   gardens and             farmers and
   hunting and             milking cows and raising

7. Christopher Columbus and other early explorers traveled the world in search

   spices and precious    wild horses and
   pirate ships and       cotton and

8. Place an M next to the actions representing people migrating.

   _____The Oregon Trail    _ _ _Ellis Island
   _____Following Buffalo
   _ _ _1930's Dust Bowl    _____Landing at Plymouth Rock
9. Match the food and fiber product on the left with the state, region, or country.

<table>
<thead>
<tr>
<th>Product</th>
<th>State, Region, or Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>____</td>
<td></td>
</tr>
<tr>
<td>____ Cranberries</td>
<td>2. Great Plains</td>
</tr>
<tr>
<td>____ Bananas</td>
<td>3. New England</td>
</tr>
<tr>
<td>____ Rice</td>
<td>4. Japan</td>
</tr>
<tr>
<td>____ Tobacco</td>
<td>5. Hawaii</td>
</tr>
<tr>
<td>____ Wheat</td>
<td>6. Carribear</td>
</tr>
</tbody>
</table>

10. Circle the issue that does **not** affect food and fiber.

<table>
<thead>
<tr>
<th>Clean</th>
<th>Price of imported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air pollution</td>
<td>Export</td>
</tr>
</tbody>
</table>

11. Food and agriculture systems rely on which natural cycle? (Circle the)

<table>
<thead>
<tr>
<th>Political</th>
<th>Heat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Marine</td>
</tr>
</tbody>
</table>
12. From the list below, circle three natural resources used in the production of

Air          Rubies          Mountains
Water         Soil            Uranium

13. Circle the reason ladybugs may be released in a garden or

To feed other insects living on
To protect plants from harmful
To add bright
To attract

14. Circle the answer that has reduced the manual labor requirement for

Teclmology          Smaller
More                  Politics

15. Circle four agribusinesses in the list

Floral Shop         Bakery         Church         Detective Agency
Pet Store          Jewelry Store    Law Firm       Lawn Service
16. Circle the least expensive

Apple pie  Fresh  Apple juice

17. The government regulates ________ (Circle the correct

Market  Farm Size
Pesticide Use  Tractor Size

18. Circle the answer showing a reason nations trade or sell
agricultural

Prevent  Reduce Commodity
Keep Prices Low  Protect the

19. Circle a reason for processing

Decrease  Reduce Cost
Improve  Remove Additives
20. Circle the answer that is **not** one of the six basic food:

- Carbohydrate
- Protein
- Water
- Fats
- Sugar
- Vitamins

21. Circle the answer showing how food choices have changed over:

- More high-fat
- More processed
- Less processed
- Less convenience

22. Which one of the following regulates food handling, preparation, and

- The Surgeon
- Individual Choice
- State
- Government
APPENDIX F

LETTER TO SCHOOL ADMINISTRATORS
Dear ________,

We are writing to ask for your help to arrange the testing of your K-6th grade students in agricultural literacy. Through this research project we hope to develop baseline data about the strengths and weaknesses of agricultural literacy in Illinois elementary school students.

Enclosed is a sample of the pre-posttests, and sample consent forms to be used in this study. *A signed parental consent form will be required for students to participate in this curriculum development program.*

The testing instruments we are using have been validated and pilot-tested, but please note that these are not standardized tests, so scores below 60 would not reflect a poor performance. Rather, the range of scores achieved among students in the topics of agricultural literacy, and comparisons of mean scores will help us immensely in understanding agricultural literacy needs of elementary students in Illinois. The tests will be administered in the students’ usual classroom setting, and only the researchers will view individual scores in order to ensure confidentiality. Thus, results will be reported only as aggregate data.

If testing is approved, we’d like to set a date some time this month for one of the researchers to travel to your school and administer the test. We will call you soon to answer any questions that may arise.

Thank you for your consideration of this important project.

Sincerely Yours,

Ms. Mary M. Fischer  Dr. Seburn L. Pense
Graduate Assistant  Professor
Agricultural Education  Agricultural Education
Ph. (618) 303-0097  Ph. (618) 453-2467
Email: cajun@siu.edu  Email: sebpense@siu.edu
A detailed 2015 Illinois School Report Card for each school participating in this study is available at:

Illinois Report Card

https://illinoisreportcard.com
APPENDIX H
ANOVA TABLES
Table 1. Analysis of Variance for pretest sensitization or test reactivity as determined by the administration of a pretest at participating schools during fall, 2015.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>Mean Square</th>
<th>F</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>4</td>
<td>469.8222</td>
<td>117.206</td>
<td>0.2402</td>
<td>0.9119</td>
</tr>
<tr>
<td>Error</td>
<td>18</td>
<td>8784.68</td>
<td>488.038</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Total</td>
<td>22</td>
<td>9253.5022</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Analysis of Variance for the effect of grade by control type at participating schools during spring, 2016.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>Mean Square</th>
<th>F</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>5</td>
<td>3937.6334</td>
<td>787.527</td>
<td>9.9814</td>
<td>0.0123*</td>
</tr>
<tr>
<td>Error</td>
<td>5</td>
<td>394.499</td>
<td>78.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Total</td>
<td>10</td>
<td>4332.1324</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Analysis of Variance for the effect of grade by treatment type at participating schools during spring, 2016.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>Mean Square</th>
<th>F</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>5</td>
<td>4496.8496</td>
<td>899.37</td>
<td>100.471</td>
<td>&lt;.0001*</td>
</tr>
<tr>
<td>Error</td>
<td>5</td>
<td>44.7577</td>
<td>8.952</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Total</td>
<td>10</td>
<td>4541.6073</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Analysis of Variance for the effect of Theme 1 by grade at participating schools during spring, 2016.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>Mean Square</th>
<th>F</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>5</td>
<td>666.537</td>
<td>133.307</td>
<td>38.081</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Error</td>
<td>17</td>
<td>59.509</td>
<td>3.501</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Total</td>
<td>22</td>
<td>726.047</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Analysis of Variance for the effect of Theme 2 by grade at participating schools during spring, 2016.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>Mean Square</th>
<th>F</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>5</td>
<td>350.387</td>
<td>70.077</td>
<td>37.146</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Error</td>
<td>17</td>
<td>32.071</td>
<td>1.886</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Total</td>
<td>22</td>
<td>382.457</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6. Analysis of Variance for the effect of Theme 3 by grade at participating schools during spring, 2016.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>Mean Square</th>
<th>F</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>5</td>
<td>459.357</td>
<td>91.871</td>
<td>42.182</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Error</td>
<td>17</td>
<td>37.025</td>
<td>2.178</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Total</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7. Analysis of Variance for the effect of Theme 4 by grade at participating schools during spring, 2016.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>Mean Square</th>
<th>F</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>5</td>
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