STEM EDUCATION CONCEPTS IN THE NUTRITION AND FOOD SCIENCE CAREER PATHWAY: A DELPHI STUDY

by

ASHLEY QUINN POLLARD

(Under the Direction of John M. Mativo)

ABSTRACT

The family and consumer sciences nutrition and food science career pathway is currently the most popular career pathway in Georgia and many Sates, yet there is very little research on the benefit of the integration of the nutrition and food science career pathway and STEM education concepts. This study seeks to gain expert thought and opinion on the integration of the nutrition and food science career pathway and STEM education concepts at the secondary level. A three round Delphi study was used to gather concepts and determine consensus. A Delphi study is appropriate for areas with little research or knowledge on the subject. Participants were sought from professional organizations and 20 accepted to be panel members.

The expert panel was asked to respond to five open-ended questions to identify science, technology, engineering, and mathematic concepts to include in the nutrition and food science career pathway as well as providing strategies and recommendations. The panel identified 101 concepts. To achieve consensus, items must have met 62.5% of the respondents fall within the median of 3 or higher on a 4-point scale and the IQR is less than or equal to 1. Of the 101 items, 96 met consensus and 20 met the highest level which was identified my median of 4 and IQR of 0. The 96 items were used to answer the research questions established for this study.

One of the major findings demonstrated the need for teachers of STEM subjects and FCS courses to collaborate and develop engaging lessons for students. Second, there was a theme for there to be more hands on experience for students, such as laboratory time and field investigations. Third finding was that STEM standards are already included in the curriculum and should continue to be used. Based on these findings, curriculum and standards can be developed and/or modified to strengthen STEM skills, abilities, and knowledge in the family and consumer science nutrition and food science pathway. Results highlight the need to stimulate interest in STEM related careers.
INDEX WORDS: Family and consumer sciences; FCS; STEM; Delphi; career pathways; nutrition and food science; career and technical education; CTE

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CHAPTER 1

Introduction

The family and consumer sciences profession has been a part of American educational system for over 100 years. Formally known as home economics, a group of professionals met in Scottsdale, AZ in 1993 to change the name of the professional field to family and consumer sciences. This name change was intended to more accurately reflect the mission and role of the profession. Home economics officially started in the United States in 1899 in Upstate New York by a group of educators, researchers, and activists who believed scientific theories could be applied to solve living conditions, poverty reduction, and women's suffrage. Family and consumer sciences critiques, improves, and studies the quality of everyday life for individuals and communities (Gentzler, 2012). Family and consumer sciences is defined by the professional organization, American Association of Family and Consumer Sciences (AAFCS), as the comprehensive body of skills, research, and knowledge that helps people make informed decisions about their well-being, relationships, and resources to achieve optimal quality of life (n.d.).

The field of family and consumer sciences represents several different specializations or areas; thereby, the designation of sciences rather than science. Some of the specializations/areas in family and consumer sciences are child and human development, personal and family finance, housing and interior design, food science, nutrition and wellness, textiles and apparel, and consumer issues (AAFCS, n.d.). Family and consumer sciences professionals practice their skills in a variety of settings. These professionals are early childhood, elementary, secondary, university/college, and Extension educators, administrators and managers, human service professionals, researchers, community volunteers, business people, and consultants. Regardless to their position, they address the issues most important to the quality of life for individuals and families. The many specializations or areas of family and consumer sciences and the evolving needs of society constitute the body of knowledge for the discipline.

The body of knowledge in the discipline was identified more than 20 years ago and continues to evolve in an effort to ensure that professionals in family and consumer sciences are addressing important and necessary issues. The overall theme for the body of knowledge of family and consumer sciences is the application of scientific principles to the management of the household. However, threads of continuity have been identified; they are cross-cutting threads and specialization/s threads. Cross-cutting threads are those issues that are integrated into different disciplines. Specialization threads are those issues that require considerable depth in one content area. The body of knowledge includes basic principles that define the discipline and revisions to accommodate changing society. For instance, at the 1999 Family and Consumer Sciences in Higher Education Summit changes were made to include digital technology, genetically modified food products, work life, and globalization (Baugher et al., 2000). Currently there is a need in the field for family and consumer sciences professionals to integrate knowledge and skills from varying disciplines (Baugher et al., 2000; Nickols et al., 2009). Based on the aforementioned need, coupled with the researchers interest in the specialization of nutrition and food science and STEM (science, technology, engineering, and mathematics), this study focused on the integration of the two disciplines into the family and consumer sciences curriculum at the secondary level.

This chapter includes the background on STEM (science, technology, engineering, and mathematics) in education, STEM education in career and technical education and family and consumer sciences education, purpose statement, conceptual framework, and research questions. Moreover, the researcher discusses how family and consumer sciences courses can integrate STEM education concepts and encourage STEM participation.

STEM Education

The disciplines of science, technology, engineering, and mathematics compose the acronym STEM. The STEM acronym originated in the 1990s at the National Science Foundation initially representing any event, policy, education, or practice involving science, technology, engineering or mathematics (Bybee, 2010). Judith Ramaley from the National Science Foundation (NSF) is credited with creating the term in the 1990s (Zollman, 2012). Before STEM, there was the acronym SMET (science, mathematics, engineering and technology). Until around 2005, many people were not familiar with the term STEM and often confused STEM with stem cell research. Sanders (2009) suggested the term *education* needed to be added when referring to STEM in education, which helped to alleviate confusion. Thus, STEM educators or STEM education is how STEM should be presented. According to Sanders (2009), simply stating STEM without the education designation could reference anything in the fields of science, technology, engineering, and mathematic. Thus, when referring to STEM in an educational setting, the terminology is titled *STEM Education*.

Although STEM has been around for decades, it has only recently become an important part of education in the United States (Asunda, 2011; Sanders, 2009). Also, in recent years STEM education has become of interest for policymakers; many view STEM education as a way to improve the United States economy and education (ACTE, 2009; Asunda, 2011). There is a growing global economic pressure on the United States to produce a workforce with advanced STEM skills however; the United States is losing strength as a leading nation in STEM education (Zollman, 2012). According to Costello (2010), a significant decline has occurred in STEM education graduates and students interested in pursuing careers in the STEM disciplines.

The shortage of STEM education graduates in the United States is partly due to a lack of students prepared to enter careers in these disciplines or pursue STEM degrees (ACTE, 2009; Carnevale, Smith, & Melton, 2011; Costello, 2012). Many students are unaware of what STEM is, find classes in the discipline boring, and are unsure of what careers in the STEM disciplines look like (Carnevale et al., 2011; Hossain & Robinson, 2012). The launch of Sputnik in 1957 created an intense urgency for education in the United States to increase the importance of science, math, engineering, and technical competencies (Gordon, 2003). Although not labeled at the time, Sputnik was one of the founding movements and driving forces for STEM education in the United States (Gordon, 2003; Sanders, 2009). Moving forward to the twenty-first century, the release of Thomas Friedman’s 2005 book, *The World is Flat,* informed the United States that China and India were on course to better prepare and produce more graduates of STEM programs. This knowledge resulted in another large surge for increased STEM education in the United States (Breiner, Harkness, Johnson, & Koehler, 2012; Sanders, 2009). Consequently, STEM education became known around the country and funding began for STEM education programs in American secondary schools. In fact, all levels of education are promoting STEM; universities have restructured degree programs to incorporate STEM models and secondary schools are developing modified curricula to include STEM initiatives (Herschbach, 2011; Sanders, 2009).

There are four disciplines in the STEM education curriculum; they are science, technology, engineering, and mathematics. Science is a broad term encompassing several fields including physics and/or chemistry. Science is a process of producing knowledge that depends on making careful observations of phenomena in the natural world and inventing theories for making sense out of those observations (Asunda, 2012). The use of scientific tools and investigation of phenomena are the major ways to discover and advance knowledge. Whereas, technology is broader than science and includes everything designed in a man-made world. There are differing opinions on how technology should be taught. Some educators believe technology should be, and is already taught through other subjects (Herschbach, 2011). Engineering, unlike science and technology, is a vocational subject typically taught on the collegiate level (Herschbach, 2011). The specific occupational area defines the engineering instruction. This presents a problem when deciding which field of engineering to use in integrated instruction, such as civil, mechanical, and industrial (Herschbach, 2011). However, engineering courses provide many opportunities to incorporate science, technology, and math. Mathematics is the most used and clearly defined STEM discipline. Mathematics, the study of patterns or relationships, explores the possible relationships among abstractions. Instruction in mathematics is typically organized around students' abilities and learning needs.

STEM education has not been easy to include in the curriculum; STEM education does not follow a specific model and is often hard to define exactly what is meant by STEM (Herschbach, 2011). Typically, students gain STEM education knowledge and skills through independent classes in the STEM disciplines or in a less obvious way through an integrated approach in courses such as career and technical education, generally (Asunda, 2011; Kidwai, 2011; Stone, 2011) and family and consumer sciences, specifically (Davis, 2010; Duncan, 2011; Shirley & Kohler, 2012).

STEM Education in Career and Technical Education

Career and technical education, formerly known as vocational education, has evolved since the 20th century. During the 20th century, career and technical education focused on jobs that did not require post-secondary education in the fields of agriculture, business, and trade and industry (Kidwai, 2011; Scott & Sarkees-Wircenski, 2008). Career and technical education courses make up a large component of United States secondary schools with 90% of students taking at least one career and technical education credit (Lynch, 2000; Stone, 2011). Today, career and technical education continues to evolve to develop a workforce with advanced skills and knowledge needed to meet today's workplace demands and global competition (Feller, 2011; Stone, 2011). Career and technical education provides practical and applied instruction to prepare students to enter the workforce or post-secondary institutions (Gordon, 2003; Scott & Sarkees-Wircenski, 2008). Additionally, career and technical education and STEM education can help prepare students to enter the workforce by teaching and stressing 21st Century skills employers look for in employees (Asunda, 2011, 2012; Bybee, 2010). Some of these 21st Century skills include self-discipline, technology skills, experience, and flexible thinking (Reese, 2012; Williams, 2011). Career and technical education implements 21st Century skills by providing hands on experience in and outside of the classroom.

Nationally and internationally, the general public and policymakers have a misunderstanding about the relevance, quality, and rigor of career and technical education (Kidwai, 2011; National Governors Association, 2007). Therefore, STEM education brings rigor to the career and technical education curriculum through technology and mathematics (Hyslop, 2010). The versatile nature of career and technical education easily allows for integration of STEM education concepts to develop STEM savvy students (Asunda, 2011; Stone, 2007; Torkar & Koch, 2012). The first step in advancing STEM education is to integrate STEM into all subject area curricula (Feller, 2011; Zollman, 2012). Through integration of STEM education concepts in career and technical education courses, students can become literate in the areas of STEM.

STEM Education in Family and Consumer Sciences Education

An area of career and technical education that is often overlooked when discussing STEM education integration is family and consumer sciences career pathways. Family and consumer sciences applies concepts from the sciences (chemistry), economics, and psychology to explore social issues such as unemployment, poverty, and malnutrition (Torkar & Koch, 2012). Family and consumer sciences attempts to answer the question “how do we maximize human potential?” (Gentzler, 2012). Today, family and consumer sciences teaches decision-making, collaboration, business, and employability skills; all of these skills complement STEM education goals identified by the National Research Council (2011) to prepare students for the workforce.

Currently, family and consumer sciences curriculum at the secondary level is organized and delivered around programs of study also known as career pathways (Georgia Department of Education, 2014; Scott & Sarkees-Wircenski, 2008). A career pathway is a coherent, articulated sequence of rigorous academic and career/technical courses, commencing in the ninth grade and leading to an associate degree, baccalaureate degree and beyond, an industry recognized certificate, and/or licensure (Center for Occupational Research and Development [CORD], 2010). The concept of career pathways is rooted in strengthening the education of all students and the career planning process; the desired outcomes are greater student achievement and preparation for the workforce (ranging from entry level to professional) or postsecondary education. Career pathways in family and consumer sciences are designed to allow students to mold their learning toward a specific career focus (Georgia Department of Education, 2006).

Family and consumer sciences career pathways at the secondary level are growing and becoming more relevant as a guide for students to enter the workforce. Based on the mission and body of knowledge, family and consumer sciences can help to improve social issues, such as unemployment; family and consumer sciences directly relates and integrates the need of STEM education to prepare students for STEM careers (Torkar & Koch, 2012). Career pathway programs work closely with partners, such as businesses and technical schools, to prepare students to be successful on the job and equipped with the skills needed to enter post-secondary programs or the workforce (Jurmo, 2011). Georgia has three family and consumer sciences career pathways at the secondary level that include consumer services, nutrition and food science, and interior design (Georgia Department of Education, 2014).

The nutrition and food science career pathway is the leading pathway in Georgia (Georgia Department of Education, 2010). The nutrition and food science career pathway can foster connections between learning and employment or college and career readiness. Careers in food and nutrition are expanding with an array of choices available (Bureau of Labor Statistics, 2006). There is little research and a deficiency in the literature on STEM education integration into the family and consumer sciences career pathways. The integration of some STEM education concepts, particularly science and mathematics, into the family and consumer sciences curriculum is natural (Darling, 1995; Davis, 1993; Hall & Williams, 1989; Lindsey & Kohler, 2012; Moss, 1989; Richards, 2000; Torkar & Koch, 2012). Family and consumer sciences teaching offers the possibility to explain and observe events. Therefore, it is important to study the integration of STEM education concepts in the nutrition and food science career pathways to meet student needs to be competitive in a global market and as a STEM nation to meet the needs of today's workforce.

Purpose Statement

The purpose of this Delphi study was to project the integration and contribution of science, technology, engineering, and mathematics (STEM) education concepts into the nutrition and food science career pathway curriculum at the secondary level. STEM education concepts are defined as *abilities, skills, and knowledge* associated with the disciplines of science, technology, engineering and/or mathematics needed to pursue a related career (Koul & Evans 2012; Shatkin, 2009). The nutrition and food science career pathway is one of three pathways in the family and consumer sciences education program in Georgia and many other states. The nutrition and food science career pathway includes three courses: Food, Nutrition, and Wellness; Food and Nutrition through the Lifespan; and Food Science. The Food and Nutrition through the Lifespan course and Food Science courses are both approved for the fourth science requirement in Georgia (Georgia Department of Education, 2009); this underscores the importance of integrating the STEM education concepts into the nutrition and food science career pathway curriculum.

This study used an expert panel from two major learned societies, the Association of Career and Technical Education (ACTE) and the American Association of Family and Consumer Sciences (AAFCS). Teacher educators and administrators were used from the Family and Consumer Sciences Division and STEM educators in the Engineering and Technology Division of ACTE. Foods and nutrition professionals were used from the Nutrition, Health and Management, and Hospitality Management Division of AAFCS. This panel was selected through nominations from well-known experts in the field. Using experts from the different sectors in this study strengthens the results as it will have direct implications for secondary teachers and the foods and nutrition pathway. According to Linstone and Turoff (1979), varying groups will offer various perspectives.

Results from this study will be used to generate discussion among family and consumer sciences educators for future planning and development of the nutrition and food science career pathway curriculum to enhance students' opportunities for STEM-related careers.

Specific research questions include:

1. With respect to skills, abilities, and knowledge, what STEM Education concepts should be included in the nutrition and food science career pathway curriculum?
2. What should the family and consumer sciences education profession do to integrate STEM Education concepts (skills, abilities, and knowledge associated with the disciplines of science, technology, engineering, and mathematics) into the nutrition and food science career pathway curriculum?
3. What should be some contributions of integrating STEM Education concepts (skills, abilities, and knowledge associated with the disciplines of science, technology, engineering, and mathematics) into the family and consumer sciences education curriculum generally and the nutrition and food science career pathway specifically?

Conceptual Framework

To ensure that STEM education concepts are infused into the nutrition and food science career pathway, it is important to understand and give attention to curriculum design. A curriculum design is the shape, gestalt or arrangement of the different parts of a curriculum plan (Ornstein & Hunkins, 2007). Curriculum design is used to guide the learning experiences. A curriculum design includes goals/objectives, subject matter, learning experiences, scaffolding and evaluation approaches as principal features.

Several different curriculum designs have been proposed for development and delivery of the curriculum. For this study, separate subject, multidiscipline, interdisciplinary, and integrated curriculum designs identified by Beane (1998) and other theorists (Finch & Cruncklin, 2001; Ornstein & Hunkins, 2007) were explored for use. According to researchers (Ewing, Foster, & Whittington, 2011; Herschbach, 2011), rather than isolating the individual disciplines of STEM education, an integrated curriculum design approach will foster deeper understanding of skills. Therefore, and after careful deliberation, the integrated curriculum design was chosen as a framework.

The integrated curriculum design has been used and defined by several researchers. According to Beane (1998), the integrated curriculum design promotes personal and social integration through the organization of curriculum around significant problems and issues that have been identified without regard for subject area lines. Pring (as cited in Loepp, 1999, p. 135) defined curriculum integration as “the very notion of ‘integration’ incorporates the idea of unity between forms of knowledge and the respective discipline.” Shoemaker (1989) defines an integrated curriculum design as one that cuts across subject-matter lines, bringing together various aspects of the curriculum into meaningful association to focus on broad areas of study. An integrative curriculum can start with an organizing theme followed by questions, projects, and activities that involve integration and application of knowledge in the context of the theme.

A key principle and focus of an integrated curriculum design is to challenge students with real world problems while maintaining a standards-based, relative curriculum for students (Loepp, 1999). These principles working together make an integrated curriculum design.

Learning experiences, for example, are just one piece. When all of the parts work together, students see the whole picture. An integrated curriculum design is the entire gestalt.

The purpose of curriculum integration is to blur subject matter boundaries and focus on real world themes or application of skills in lessons (Brinegar & Bishop, 2011). Integration can be accomplished by organizing content between subjects typically taught in separate courses or fields (Malik & Malik, 2011). Moreover, the goal in this study with the integration of STEM education and the nutrition and food science career pathway.

Some of the content in family and consumer sciences is deeply rooted in the sciences (Hall & Williams, 1989; Moss, 1989) and other STEM education disciplines (Gentzler, 2012; Lindsey & Kohler, 2012; Torkar & Koch, 2012). Therefore, an integrated curriculum design with STEM education and the nutrition and food science career pathway develops cross-curricula authentic connections. An integrated curriculum design between STEM education and the family and consumer sciences classroom will better prepare students for career and post-secondary education paths and the real-world challenges students will encounter (Torkar & Koch, 2012). Loepp (1999) determined this to be true in career and technical education classrooms and family and consumer sciences in no exception.

Integrating STEM education concepts into the courses of the nutrition and food science career pathway may help to stimulate interest in STEM related careers. This research study explored how an integrated curriculum design could occur in the family and consumer sciences nutrition and food science career pathway using the Delphi method. Bringing together STEM education concepts with family and consumer science food and nutrition pathway curriculum, meaningful associations can be developed to focus on broad areas of study in the respective fields. The principals of the integrated curriculum design were used to analyze the results of this study to determine ways an integrated curriculum design can happen between the STEM disciplines and the family and consumer sciences nutrition and food science career pathway.

Importance of Study

The intent of this study was to identify how science, technology, engineering, and mathematics (STEM) education concepts can be integrated into family and consumer sciences nutrition and food science career pathway at the secondary level. STEM education concepts are the skills, abilities, and knowledge associated with the STEM disciplines. An understanding of these concepts will help prepare students for post-secondary training, education, or careers in the STEM disciplines (Carnevale et al., 2011).

A knowledgeable panel of experts participated in a Delphi survey to examine the integration and contributions of STEM education concepts into the family and consumer sciences nutrition and food science career pathway. Current research shows there is a need for STEM education ready students to enter the workforce and meet the demands for the current workforce (Carnevale et al., 2011; Costello, 2012). Results of this study may contribute to the development of an integrated STEM education and family and consumer sciences nutrition and food science curriculum to contribute to meeting the demands of today's workforce.

There is a need in America for students to pursue degrees in the disciplines of science, technology, engineering, and mathematics (Carnevale et al., 2011; Costello, 2012; Feller, 2011). Family and consumer sciences and career and technical education courses are popular amongst high school students, with some career and technical education programs already integrating STEM education concepts (Kidwai, 2011; Stone, 2011). However, there is little research on the integration of STEM education concepts in family and consumer sciences courses. Therefore, the results of this study show how STEM education concepts can be integrated into the family and consumer sciences nutrition and food science courses to gain student interest in STEM and improve knowledge of STEM concepts.

There is a void in the research on integrated STEM education concepts in family and consumer sciences, specifically the nutrition and food science career pathway. This study addresses this void by identifying and prioritizing what a knowledgeable group of experts perceive the future of STEM education concepts integrated into the family and consumer sciences nutrition and food science career pathway. Results from this study may contribute to the development of a family and consumer sciences nutrition and food science curriculum integrated with STEM education concepts. The identified and prioritized items are important for future development of family and consumer sciences career pathways.

CHAPTER 2

Review of Literature

The purpose of this chapter is to provide an overview of the related literature and research for this study. The beginning of this chapter introduces integrated curriculum design and other models of curriculum integration. The second section of this literature review describes the role of science, technology, engineering, and mathematics in education and career pathways. The final section describes the use of Delphi technique in educational research.

Curriculum Design

A curriculum describes the standards and sequence that should be taught for a given subject. Additionally, curriculum details what students should learn and successfully challenge students to understand standards upon course completion (Loepp, 1999). According to Loepp (1999), there are four curriculum design approaches: separate subject, multidiscipline, interdisciplinary, and integrated curriculum. The curriculum is used to guide the learning sequence and experiences (Ornstein & Hunkins, 2007).

A separate subject curriculum, isolated subject, teaches students content and standards from a given subject without influence or standards from another subject; it is isolated (Brown, 2011; Malik & Malik, 2011). For example, a chemistry course would only teacher chemistry skills and knowledge. Historically career and technical education was taught separately from other disciplines; however, in recent years there has been movement for career and technical education to be integrated with all subject areas (Pearson & Sawyer, 2010).

Multidisciplinary and interdisciplinary curriculum approaches aim to cross subject boundaries. The purpose of a cross-curricula approach is to help students solve real-world problems, which are typically multidisciplinary in nature (Loepp, 1999). An integrated curriculum and an interdisciplinary curriculum are similar. An interdisciplinary or multidiscipline curriculum still maintains subject boundaries (Loepp, 1999). In an interdisciplinary classroom the teacher typically is consciously using language or methodology from other subjects. However an integrated curriculum attempts to use a wider approach across multiple disciplines to solve problems together, naturally as one curriculum (Loepp, 1999).

Curriculum Integration

An integrated curriculum design allows students to get the whole idea or objective. Integrated curriculum design helps to keep education relevant and interesting for students in school (Loepp, 1999). Curriculum integration in the career and technical education classroom requires more than two sets of discipline standards coming together (Pearson & Sawyer, 2010). An integrated curriculum design brings together core principles, as opposed to a single model. An integrated curriculum design is the gestalt, all of the parts that make up a curriculum design working together. Integrated curriculum takes the individual parts or pieces together to make a whole. For instance, students can integrate knowledge and skills from a nutrition and economics course by developing a business model and recipe for a bake sale to benefit a school club. An integrated curriculum design features principles of the various models to form the goals, objectives, evaluations, strategies, and learning experiences (Loepp, 1999; Pearson & Sawyer, 2010). Sanders (2009) believes an integrated STEM education is necessary because stand-alone STEM subjects face serious challenges such as little student interest.

Beane (1998) declares successful curriculum integration occur when the learner takes knowledge learned and is able to construct new meanings about self and the world. Curriculum integration makes teaching and learning activities more meaningful and helps to develop deeper understanding of skills (Ewing, Foster, & Whittington, 2011; Loepp, 1999). Preparing students to overcome real world problems is a key principle and focus of integrated curriculum, while maintaining a standards-based, relative curriculum for students (Loepp, 1999). These principles working together make an integrated curriculum design. Learning experiences, for example, are just one piece. When all of the parts work together, students see the whole picture. Curriculum integration is used to make the teaching and learning activities more meaningful.

There are many ways to integrate curriculum identified in the literature. One way integration can be accomplished is by organizing teaching matter between subjects typically taught in separate courses or fields (Loepp, 1999; Malik & Malik, 2011). To begin, time will be needed to plan, organize, and execute the integrated curriculum. Malik and Malik (2011) suggest first integrating a few module or phases of a course at a gradual pace as it can be overwhelming to integrate an entire course curriculum. Curriculum integration should be both horizontal and vertical. Meaning, horizontal integration of parallel disciplines, and vertical as phases of curriculum typically taught in different phases of the curriculum (Leung 2012). Therefore for integration to be most beneficial, teachers and administrators need to implement a horizontal and vertical approach to integration. To manage and organize curriculum integration, curriculum should be broken down to modules or phases. Learning outcomes need to be developed for the new integrated curriculum. Learning outcomes should be short and communicate essential skills learners should achieve by the end of the class (Malik & Malik, 2011).

To integrate the curriculum, leaders and teachers should map the curriculum content including topics, skills, and attitudes to be developed for the individual disciplines. After mapping the curriculum, themes should emerge and form into unit disciplines. By focusing on themes, meaningful connections can be made between disciplines and assist in demonstrating the relevance of the learning (Malik & Malik, 2011). After teachers and administrators have developed an integrated curriculum, it is essential to communicate this with other staff and students. Well-informed staff members will ensure successful implementation and help students identify their roles and expectations. Finally, teachers and administrators must be willing to accept shortcomings, reevaluate, and make necessary changes.

To illustrate an integrated curriculum, two such studies are reported. First, Brinegar and Bishop (2011) conducted a study to examine how middle school students perceive engagement in integrated curriculum. They found that students who are engaged in content often feel enthusiasm, immersed, involved, and feature success. Their study followed 13 sixth graders from sixth grade through ninth grade. All students were interviewed once a year and observed all students over the course of the study. Students were asked to reflect and describe parts of learning that were engaging and not engaging. Examination of the data identified clear themes and commonalities. As students progressed through the years and developed more understanding, they were able to articulate the benefits of engaged learning. By eighth grade students were able to understand the connections between process and product. By the ninth grade, students valued integrated learning. Therefore, it is important for educators to close the gap between academic learning and real-world skills.

The second study designed for integration was conducted in 2012 by researchers from North Carolina State University in the STEM department. Researchers developed and piloted an integrated STEM education project. The researchers worked with two middle school teachers and four eighth grade students during the fall semester. The researchers saw a need to prepare students with STEM-based experiences and understandings in all courses to prepare learners beyond the classroom (McCulloch & Ernst, 2012). The researchers proposed STEM education should be authentically integrated into all areas of curriculum to enhance STEM understanding and prepare for the STEM workforce. The researchers used a problem-based learning approach to solve the need for a water-quality instrument. The results of the study determined the semester long project helped to improve student engagement and helped students to see how the areas of STEM relate to their lives and future (McCulloch & Ernst, 2012). Intentionally integrated STEM projects proved to be successful.

Curriculum Integration Models

The literature was searched and several models for curriculum integration were found for educators to explore and use in the classroom. An explanation of these models will follow. The first group of eight models of curriculum integration that will be explored was constructed for career and technical education by career and technical education professionals (Grubb, 1991). Those models include senior projects, the Academy model, incorporating academic content in vocational courses, combining vocational and academic teachers to enhance vocational programs, making academic courses more relevant, horizontal/vertical curricular alignment, occupation high schools and magnet schools, and career paths. The aforementioned models were developed as a reform strategy to improve education and employment opportunities of students (Lankard, 1992). Some of the models were curricula alignment, the Academy model, and the senior project as a form of integration (Lankard, 1992). These models included strategies such as adding more academic content, making core classes more vocationally relevant, project based learning, magnet schools, and occupational clusters (Grubb et. al, 1991). However, limitations such as segregation of vocational and academic tracks still remain and little collaboration between teachers (Lankard, 1992). Upon careful review of the models, they were deemed inappropriate for this study.

The second model reviewed and considered for this study was the collaborative model. The collaborative model uses a spiral approach, which proceeds through tasks to develop a complete curriculum (Conceicao, Colby, Juhlmann, & Johaningsmeir, 2011; Chernu & Fowler, 2010; Leung, 2012). During the progression towards completion, phases incorporate essential elements, such as learner outcomes and assessments (Conceicao et al., 2011). A team should be established of appropriate members, such as teachers and administrators. There are five phases during the collaboration process: define, design, demonstrate, develop, and delivery (Conceicao et al., 2011). In the define and design phase, the team will identify learners needs, specific outcomes, standards, assessments, develop a scope and sequence, and curriculum evaluation. Next, the team will create draft documents and activities in the demonstrate phase. Drafts will need to be monitored to ensure that they are appropriate for learners. Drafts should be tested on learners then evaluated to make changes as necessary. Next, the team can enter the develop phase to ensure evaluated materials are appropriate, assessments are included, and materials match instructional strategies (Conceicao et al., 2011). After all steps have been complete, the team created curriculum is ready for delivery. Although the process seems long, progression should occur naturally (Conceicao et al., 2011). Communication and management are critical for successful curriculum design for this model.

A third model identified was an interdisciplinary model. The interdisciplinary model for curriculum integration puts groups of traditional students into block periods and provides the students with a group of teachers to attempt to team-teach and provide an integrated curriculum (Johnson, Charner, & White, 2003; Leung, 2012; Loepp, 1999). Interdisciplinary models are commonly seen in middle schools to teach the core subjects. However, according to Loepp (1999) it is easy for teachers to ignore the integrated portion of this model and teach to the core subjects. An interdisciplinary model attempts to encourage students to explore other subjects not directly related to the specific subject being studied (Johnson et al., 2003). When done correctly, interdisciplinary curriculum will reinforce academic learning while meeting state standards.

The final model reviewed was the problem-based model. One way to implement integrated curriculum is through problem-based learning. The problem-based model uses other disciplines to support solving problems, typically surrounding technology education (Loepp, 1999). The major advantage to this model is the use of highly relevant, motivating problems students can relate to (Loepp, 1999). Teachers can use problem-based learning when integrating STEM concepts to increase critical thinking, innovation, and real-world problem solving skills (Zollman, 2012). However, this model heavily favors technology and is difficult to ensure standards and frameworks are used (Loepp, 1999).

Integrated Curriculum and STEM

The fields of science, technology, engineering, and mathematics (STEM) have been a part of American education for decades (Zollman, 2012). For instance, in 1957 there was a large push for more rigorous STEM courses after the launch of *Sputnik* (Gordon, 2003). The National Science Foundation (NSF) originally began using SMET to represent the STEM disciplines until a program officer commented that SMET sounded too similar to smut (Breiner, Harkness, Johnson, & Koehler, 2012; Sanders, 2009). Presently, the 21st Century demands more scientific and technological innovators for the global economy and meaningful employment is needed for the current STEM generation (Asunda, 2011; Zollman, 2012). Proponents of STEM education feel that the area will provide real-world relevance, develop confidence in learners, decrease dropout rate through a relevant education experience, encourage students to think flexibly, increase STEM literacy, bring excitement to math and science, and create the desire for learners to explore (Carnevale, Smith, & Melton, 2011; Williams, 2011).

However, STEM education needs improvement (Asunda, 2011; Herschbach, 2011; Hyslop, 2010). For instance, there is a lack of clarity in STEM education in its definition and implementation (Zollman, 2012). Currently there is no clear definition on STEM education on the particulars and standards that define STEM literacy (Zollman, 2012). For instance, Williams (2011) found in some schools technology is linked to engineering courses and not other areas that would be applicable, such as food technologies. Therefore, this particular STEM approach may limit a student's technology literacy, as other areas are not exposed to the student to explore (Williams, 2011). A lack of clarity may prevent students from taking STEM courses when students are unsure of what the curriculum entails. STEM is naturally integrative; students need to understand what STEM looks like in the world beyond secondary school (Herschbach, 2011; Torkar & Koch, 2012). Furthermore, there is evidence technology education is overlooked and not a priority for the STEM agenda (Zollman, 2012).

America needs to encourage and produce more STEM graduates or it risks losing its title as a world leader in STEM education and threaten economic security (Costello, 2012; Feller, 2011). The Federal Government recognizes the need for an improved STEM education and provides support for STEM education programs via grants and initiatives (Executive Office of the President, 2011). There are a variety of reasons why STEM education is important and relevant to a 21st Century education. STEM education is currently the driving force for today's high-demand jobs with growing global economic pressure in need of STEM innovators (Asunda, 2011; Carnevale et al., 2011).

Additionally, politicians have recognized the need for STEM education and President Obama announced in 2009 a set of STEM initiatives to promote the STEM agenda (Williams, 2011). Despite the current state of our economy and lack of jobs, there is a shortage of workers ready to enter STEM fields (Carnevale et al., 2011; Kidwai, 2011). Policymakers are noticing the positive connection between STEM and other fields, such as career and technical education.

In an integrated curriculum design classroom, students will work together to discover knowledge and apply knowledge learned to solve problems across fields (Loepp, 1999). The separate fields of STEM should overlap and integrate into other fields for more effective understanding of STEM concepts (Zollman, 2012). According to Zollman (2012), understanding of STEM concepts needs to go beyond the content and fields, to reach personal, societal, and economic needs. STEM subjects need not to be looked at as separate individual fields. For instance, Zollman (2012) suggests there cannot be a separate engineering curriculum; STEM concepts should be integrated into other disciplines. An integrated curriculum design between STEM concepts and family and consumer sciences provides a contextual approach to learning (Stone, 2011). A contextual approach provides learning within a real-world context (Stone, 2011). Therefore, students connect the content with the context.

Career and Technical Education Integrated with STEM Education

There is concern from labor market forecasters about the promotion of career development. As the U.S. economy continues to rebuild, communities face a lack of STEM skilled workers needed to reduce economic pain (Asunda, 2011). Students planning post-secondary options need both, academic and technical skills. Rigorous career and technical education programs that include integrated STEM curriculum, work-based learning, and student organizations have proven to be a cost-effective strategy to help students prepare for the future (Zollman, 2012). Students are best served when academics and career and technical education are integrated and provide a real-world context. With the changing workplace, curriculum must change and incorporate STEM options. Shatkin (2009) defines STEM occupations as “those requiring knowledge of or skill with science, technology, engineering, or math.” There are a wide variety of STEM related careers; however, STEM workers primarily use more than one area of STEM (Shatkin, 2009). STEM careers advance and change rapidly. Therefore, STEM workers need the ability to be lifelong learners to continually update skills. Entering the STEM career pathway has many advantages. For instance, the current economy is driven by technology and nearly every job uses technology somewhere. STEM careers are in high demand and are expected to grow by 10.7% over the next decade (Feller, 2011).

STEM education is often viewed as a priority for students for future employment and education (Asunda, 2011). Career and technical education curriculum integrated with STEM concepts is one way to address the need of STEM education. The Perkins legislation requires career and technical education courses to be integrated with rigorous and challenging curriculum (Pearson et al., 2010). An integrated curriculum is more than just strategies. An integrated curriculum design features principles of the various models to form the goals, objectives, evaluations, strategies, and learning experiences (Loepp, 1999; Pearson et al., 2010). An integrated curriculum design brings relevance and will help answer the question “When will I ever use this?” (Loepp, 1999).

According to Asunda (2011) and Torkar and Koch (2012), career and technical education is versatile in nature, which provides a platform for integration of STEM concepts to provide all students with a STEM geared curriculum. Asunda (2011) reviewed several STEM initiatives in career and technical education secondary courses attempting to enrich STEM concepts in career and technical education courses. Asunda (2011) found schools and organizations that support STEM initiatives provided students with the skill sets and knowledge needed for the 21st century. The skill sets and knowledge better prepare students to be innovative and make connections between the four STEM disciplines and general education (Asunda, 2011).

An area of STEM education that can be improved in schools is literacy in technology. Career and technical education programs incorporate technology into the curriculum and experiences to help meet the technological standards employers seek. For instance, Patrick Stoddart, a senior at Lee's Summit High School in Lee's Summit, Missouri created a new calendar system at his school after seeing a need for better communication (Kidwai, 2010). This calendar system will better communicate school event and activities that will send e-mails and text messages to the community (Kidwai, 2010). Patrick worked with marketing students to develop a marketing and financial plan for Patrick's calendar system. This is one example of career and technical education students learning and using STEM education concepts effectively.

To explore an integrated curriculum deeper, research was conducted in secondary schools to examine what an integrated STEM curriculum looked like in practice. Researchers who visited schools that integrate career and technical education classes with STEM concepts found students were able to make connections between the disciplines to develop projects utilizing skills from both (Kidwai, 2010; Torkar & Koch, 2012). According to Torkar and Koch (2012), family and consumer sciences courses naturally integrate with natural science and mathematics. Students learn chemistry without realizing they are having a science lesson. For instance, students use math skills when calculating unit price and measurement conversions and science skills when observing a compound changing directly from a solid to a gaseous state with carbonated beverages (Miller & Tulloch, 1989). Furthermore, culinary students created their own coffee and used marketing and math skills to market the coffee. These students were able to make the connections of STEM and career and technical education concepts to become profitable along the East Coast (Kidwai, 2010). The students made over $10,000 in three years with profits going into the technology fund at their school (Kidwai, 2010).

In 2008, faculty at the University of Georgia developed a teacher workshop with the purpose of integrating math and science into agriculture education. The researchers used the National Science Education standards and the National Council of Teachers of Mathematics standards for science and math content to be used with problem-based and inquiry-based learning (Foutz, Navarro, Hill, Thompson, Miller, & Riddleberger, 2011). The workshops are used to illustrate how students and teachers can make the connection between academic learning and solving real-world problems (Foutz et al., 2011). The project is ongoing therefore the researchers are able to only report themes. The researchers found the workshop helped increase teacher content knowledge in math and science to better prepare lessons and appears to be successful (Foutz et al., 2011). However, they suggested to focus more on hands-on activities and to separate students by grade levels.

James Stone, one of the leading researchers in career and technical education and STEM education has written several articles on the use of STEM knowledge in career and technical education courses. In 2007, Stone completed a study on the use of math skills in career and technical education. In his study he used math skills that logically complemented the CTE curriculum; math is to be taught in its natural context (Stone, 2007). The main goal of this study was to determine if enhancing math content in career and technical education courses would increase math performance. Additionally, the study investigates if a strong math career and technical education curriculum would reduce the need for math in remediation in postsecondary options (Stone, 2007). The study used career and technical education teachers, math teachers, and 3,000 students. The results of this study concluded students showed significant gains in traditional math skills and in the college placement test with an enhanced math, career and technical education curriculum (Stone, 2007). Moreover, the enhanced math did not reduce career area learning and therefore, math and career and technical education teachers should work together to develop curriculum and lessons.

Stone completed another study in 2011 showing all career and technical education programs include some aspect of science, math, technology; some will include engineering (Stone, 2011). Moreover, career and technical education courses address STEM careers, such as nurses, auto-technology, machinists, and other types of technicians (Stone, 2011). Stone (2011) found that students who participate in STEM centered career and technical education programs have three major delivery systems: regional shared-time centers (students spend part of the day in home school and part of the day at the centers), career and technical education high schools, and career and technical education offered within traditional comprehensive high schools. Most traditional comprehensive high school offers occupation clusters and pathways through courses such as family and consumer sciences. The career clusters and pathways often include STEM related curriculum (Stone, 2011).

Family and Consumer Sciences Education

Family and consumer sciences (FCS), formerly known as home economics, was founded in Lake Placid, NY in September of 1899. At the time America was facing poverty, immigration, crowded cities, and women’s suffrage. Activists, educators, and researchers convened at a conference in Upstate New York to find a way to solve the deteriorating living conditions in the home and community (Gentzler, 2012). This group developed the founding body of knowledge for the new profession called home economics. The conference attendees agreed that home economics should have its own course of study at post-secondary institutions (Gentzler, 2012). By 1909, the American Home Economics Association (AHEA) was created and is now known as the American Association of Family and Consumer Sciences (AAFCS). The AAFCS mission is "to provide leadership and support for professionals whose work assists individuals, families, and communities in making informed decisions about their well-being, relationships, and resources to achieve optimal quality of life" (AAFCS, n.d.). The AAFCS values the development of life-long learning, being a productive member of society, and support the family and consumer sciences body of knowledge.

Family and consumer sciences education has been a vocational education program (currently, career and technical education) since the first federal vocational legislation was passed in 1917. Home economics education was included as a vocational education program because the primary occupation of women at that time was homemaking. The Vocational Education Act of 1963 established two types of programs; one program leading to gainful employment, the other focused on the work of the home.

Home economics taught people the decision-making skills they needed to find best solutions to everyday situations they faced. In the late 1970's, the mission of home economics was updated to provide individuals and families with the education to help themselves to be analytical and productive members for families and society (Gentzler, 2012). This change revised school curriculum to challenge students to think analytically about underlying issues and seek solutions (Gentzler, 2012). For instance, students will not only learn how to sew, but will also be able to analyze why people believe they need designer jeans, and understand the environmental effects of indigo dye. Home economics continued to use other disciplines, such as chemistry, that connected to daily life (Gentzler, 2012).

Family and Consumer Sciences Education serves a vital role for preparing students for the demands of adult life. Studies of Family and Consumer Sciences Education classes have documented successes in preparing students for life and the importance of the subject (Smith, 2007; Weiner, 1984). In 1993, at a meeting of home economics professionals, family and consumer sciences was chosen as the new name of the profession. This was to reflect society changes (Thaler-Carter, 2000). Since then, the name has come to reflect a renewed identity and mission of the profession. This name change was intended to more accurately reflect the mission and role of the profession and was an impetus for subsequent changes. For secondary programs in middle and high schools, the occasion of the name change has provided an opportunity to review the content and role of programs as they have changed from Home Economics to Family and Consumer Sciences. For instance, clothing and textile courses have evolved from pattern making and sewing to alterations and garment care (Thaler-Carter, 2000). This change occurred because it is financially more feasible to buy your clothes from a store rather than making your own clothes. In recent years, career and technical education has been used to represent courses and programs preparing youth and adults for careers, this includes family and consumer sciences.

Moving into the 21st century, Karen Brown, the 2004 Alabama family and consumer sciences teacher of the year, identified a need to prepare students for the workforce though the family consumer sciences curriculum. Her goal was to develop career awareness and better develop life skills. Brown believed a nutrition and food science career academy could teach students valuable life skills, expand opportunities, and prepare students to be productive members of society (Brown, 2005). Brown received city approval and the culinary arts academy was fully equipped and ready to open in 2003. Brown created a popular program by using dynamic, hands-on lesson plans which include team-teaching with the biology, physical education, Spanish, history, and computer science teachers at her school. After one year, the academy had become the most popular class, and produced student publications in culinary magazines (Brown, 2005).

STEM Education in Family and Consumer Sciences Research

Since the Carl D. Perkins Career and Technical Education Improvement Act of 2006, career and technical education courses, including family and consumer sciences, are mandated to offer rigorous curricula (Duncan, 2011). On July 31, 2018 the President signed the Strengthening Career and Technical Education for the 21st Century Act into law which reauthorizes the 2006 Act, now referred to as Perkins V (Carl D. Perkins Career and Technical Education Act, n.d.). However, there is no clear definition of rigor in family and consumer sciences courses (Duncan, 2011). It is suggested to increase the integration of core subjects, such as science and math, with family and consumer sciences courses (Duncan, 2011). The integration of family and consumer sciences with STEM can develop rigor in the curricula.

Similar to career and technical education programs, family and consumer sciences historically have integrated components of STEM education concepts into courses. For instance, Tennessee schools in 1992 combined nutritional studies with science standards. Outlined by Freeman (1992), the University worked with the Tennessee Department of Education to change the nutritional studies curriculum to include scientific knowledge. Teaching teams were composed of both family and consumer sciences teachers and science teachers; the teams were trained on the new curriculum and team teaching methods. The new curriculum included critical thinking and reasoning, laboratory emphasis, and chemical reactions and properties of food. The results from the new curriculum showed improved relations between academic and vocational departments and courses (Freeman, 1992).

Family and consumer sciences naturally align with STEM education concepts (Duncan, 2011; Shirley & Kohler, 2012; Torkar & Koch, 2012). For instance, in the nutrition and food science career pathway students are required to use science knowledge to analyze physical, chemical, and biological properties of process systems as they relate to digestive and immune systems (Georgia Department of Education, 2014). Furthermore, other family and consumer sciences objectives aligning with STEM include analyzing biological traits, using math skills to calculate unit costs, and solving problems with technology (Georgia Department of Education, n.d.). This integration can increase rigor in family and consumer sciences courses.

Furthermore, in 2011, Anderson and Swafford examined a project using hydroponic gardening to integrate the nutrition and foods pathways with food science to combat high obesity rates in high schools. The university researchers for this project collaborated with teachers from content areas and students. Their goal was to successfully integrate concepts from math, science, and technology with CTE course content to enhance problem-solving skills, align with curriculum standards, and teach the importance of fruits and vegetables to reduce obesity (Anderson & Swafford, 2011). Thirty students from FCS and CTE (Agriculture) classes had their height and weight calculated to form their starting body mass index (BMI). After two years, the participants BMI did not change drastically. However, the food frequency data did reveal an increase in fruits and vegetables to reach the suggested daily guidelines. However, the researchers note the integration was successful as students were engaged with rigorous academic content in CTE and FCS courses (Anderson & Swafford, 2011).

A year later, Shirley and Kohler (2012) from Utah State University addressed the need for family and consumer sciences courses to reinforce STEM education concepts. The researchers discovered in their study the need for students to enter science and engineering fields to ensure America's economic growth (Shirley & Kohler, 2012). According to their study, family and consumer sciences, specifically the clothing and textiles curriculum, and STEM have parallels that can prepare students for careers related to design, production, and distribution (Shirley & Kohler, 2012). The researchers presented a research-based strategy for teaching STEM concepts through the clothing and textiles curriculum using a five phase inquiry strategy. This strategy reinforces investigating a problem rather than focusing on the solution (Shirley & Kohler, 2012). The strategy involves laboratory-based experience to strengthen STEM skills to prepare students for a STEM driven workforce. Shirley and Kohler (2012) found the relationship between STEM concepts and family and consumer sciences courses should continue to be developed as this relationship strengthened secondary students comprehension of STEM concepts.

Career Pathways

Career pathways are designed to advance education while preparing students with the skills needed to enter the workforce (Symonds, Schwartz, & Ferguson, 2011). Career pathway programs work with state agencies, community colleges, technical schools, businesses, and private foundations to organize career pathway programs that will produce successful students (Jurmo, 2011). Career pathways provide the student with the education and skills needed, and provide employers with well-prepared workers. There are many key components to successful career pathway programs. Some of these components are collaboration among stakeholders, helping learners attain real jobs and relevant credentials, providing authentic education, use of effective learning strategies and methods, provide student support, and a clear goal-driven pathway with benchmarks (Jurmo, 2011).

Career pathways in career and technical education when integrated with STEM education concepts will assist students in the varied pathways leading to STEM related careers (Hyslop, 2010). Career pathways can expose students to careers they never imagined, especially in STEM related fields. Of the 16 career clusters recognized by the Office of Adult and Vocational Education and the National Association for State Directors of Career and Technical Education Consortium, there are 81 career pathways, 6 are considered to be STEM-intensive (Hyslop, 2010). Career and technical education career pathways lead students to definitive STEM related careers, such as laboratory technician and dietician, or post-secondary STEM related degree programs (Hyslop, 2010).

In Georgia, there are currently three family and consumer sciences career pathways; they are consumer services, nutrition and food science, and interior design (Georgia Department of Education, n.d.). According to the Georgia Department of Education (n.d.), the consumer services pathway includes courses in consumer awareness, consumer finance, and consumer skills. Nutrition and food science includes courses in nutrition and wellness, nutrition through the lifespan, and food and science. The interior design pathway includes courses in foundations of interior design, furnishings materials and components, textile sciences, and interior design internship. As of the 2008-2009 school- year, a new graduation requirement in Georgia requires all students to have four years of science (Autrey & Smith, in press). Many career and technical education courses satisfy this requirement; for instance, the food and nutrition through the lifespan and food science are both approved for the fourth science requirement in Georgia (Georgia Department of Education, 2009).

In Georgia, the leading family and consumer sciences career pathway is the nutrition and food science pathway (Autrey & Smith, in press). The Georgia Department of Education reports 79% of family and consumer sciences students in a career pathway select the nutrition and food science pathway (Georgia Department of Education, 2009). The description of the nutrition and food science career pathway in Georgia is "Students will apply principles of food science, food technology, and nutrition and their relationships to growth, development, health, and wellness to support informed decision-making that promotes good health" (Georgia Department of Education, n.d.). The nutrition and food science career pathway includes three courses: Food, Nutrition, and Wellness; Food and Nutrition through the Lifespan; and Food Science

The Delphi Technique

Developed by the Research and Development Corporation (RAND), the Delphi technique is a survey study consisting of multiple (iterative) questionnaire rounds designed to reach consensus among a selected group of experts on a given topic. This flexible process uses a series of questionnaires to gather feedback on a particular research question. The Delphi technique is widely used and accepted by researchers in many fields, such as education, defense, healthcare, and information technology (Chia-Chien & Sandford, 2007; Skulmoski, Hartman, & Krahn, 2007). Delphi uses knowledgeable participants in geographically dispersed areas to collectively respond to questions or issues relying on their expertise (Davis & Alexander, 2009). The results of a Delphi study can be used for policy formulation and decision-making. Originally developed for business and government prediction, today the Delphi technique is widely used in education fields and considered one of the most beneficial forecasting measures (Nworie, 2011; Skulmoski, Hartman, & Krahn, 2007).

The RAND Corporation developed the Delphi survey in 1953 with two purposes. First, to predict the future defenses needs of the U.S. military. The second goal was to improve decision-making skills of individuals and refine group judgment (Dalkey, 1969). In 1968, RAND conducted a series of experiments to evaluate Delphi procedures. The experiments examined a comparison of face-to-face interactions and anonymous controlled feedback. The experiment results found that face-to-face interactions produced less accurate group estimates when compared to anonymous controlled feedback groups (Dalkey, 1969). Anonymity reduces the effect of dominating personalities. Using controlled feedback in a sequence of rounds, which provides participants with results, is a way to reduce noise. Statistical group response is a way to reduce group pressure. Dalkey (1969) believed the features of Delphi are most useful when group acceptance is desired, particularly for policy formation. Since the development of this technique, Delphi remains a popular method for gaining group consensus.

The Delphi technique is an accepted and popular method for achieving group consensus. The purpose of Delphi is to gather feedback on a particular research question via an iterative, flexible process using a series of questionnaires to gather feedback on a particular research question (Murphy, Black, Lamping, McKee, Sanderson, Askham, & Marteau, 1998). There are many benefits for this technique. The ability to forecast trends, without the limitations of time and geographical location is one benefit of this technique (Nworie, 2011). According to the literature, the main features and advantages of Delphi are anonymity, iteration, controlled feedback, and statistical aggregation of group response (Dalkey, 1969; Nworie, 2011; Skulmoski et al., 2007). The RAND study from 1968 found anonymity reduces the effect of dominating personalities. Using controlled feedback in a sequence of rounds, which provides the participants with results, is a way to reduce noise. Additionally, statistical group response is a way to reduce group pressure and provide a shared responsibility (Dalkey, 1969).

There are several advantages for using the Delphi survey. First, anonymity minimizes the chance of bias or bandwagon effects, dominating personalities, and group pressure (Nworie, 2011). Delphi participants are not required to meet face-to-face. Feedback is provided to respondents through a sequence of rounds. In between rounds, a summary of results is calculated from the previous round results. Items are compiled and sent back to participants to consider their earlier responses given new information about group tendencies. In this manner, all members are equally represented; the statistical group response reduces group pressures and allows each member to be represented (Dalkey, 1969). The Delphi survey is flexible; participants view newly calculated descriptive data and are encouraged to make revisions to their responses based on the feedback they receive (Davis & Alexander, 2009). The Delphi survey, when well designed, requires less effort than meeting face-to-face from participants and is financially more affordable due to no travel costs. Therefore, Delphi is practical when face-to-face methods are not realistic and anonymity creates a shared responsibility among participants producing more accurate results (Couch, Felstehausen, & Webber, 1998).

In a Delphi study, participants never meet face-to-face. Instead, participants are sent questionnaires via electronic mail or postal and asked to provide feedback on a research question. The only group interaction in Delphi is through written feedback of the other participants' judgments, which the researcher provides in subsequent rounds (Murphy et al., 1998). Since feedback is the only communication amongst participants, the role of feedback is essential (Murphy et al., 1998). Feedback in a Delphi study typically includes descriptive statistics such as means or group medians. One way to investigate how science, technology, engineer, and mathematics (STEM) concepts and family and consumer sciences can be integrated is through a Delphi Study.

The driving force for using Delphi is the thought that "collective opinions of expert panelists are of richer quality than the limited view of an individual" (Nworie, 2011). Participants in a Delphi study are typically referred to as expert panelists. The amount of participants suggested for a Delphi study varies amongst the research (Nworie, 2011). The panelists are able to proceed at their own speed without the influence of others. Panelists should be professionals in their field and able to use their knowledge to provide informed views or opinions (Nworie, 2011). The Delphi technique relies on expert opinion therefore, knowledge in the field is essential for panelists.

While a typical Delphi study has three rounds, the range of Delphi possibilities varies depending on the goals of the researcher. Typically, rounds continue as needed to reach consensus, which is established by the researcher at the start of the study. Participants are allowed and encouraged to reexamine previous judgments in round three. In subsequent rounds, panelists will be asked to reconsider prior responses until a pattern of consensus or stability is formed. Stability is achieved when shifting of responses has ended (Nworie, 2011). Most Delphi studies use descriptive statistics such as means, standard deviations, percentages, and interquartile ranges (IQR) for measuring participants' and group responses and to indicate when consensus is achieved. The mean is used as the primary measurement because for most distributions it is efficient at estimating the population means (Davis & Alexander, 2009). A pilot study should be used to make adjustments and work out any procedural problems (Skulmoski et al., 2007). Additionally, pilot testing is beneficial for new researchers who may underestimate the time it will take panelist to fully respond to a Delphi survey.

A typical Delphi survey includes 15-30 participants who complete three or four rounds of survey feedback (Couch et al., 1998). According to Murphy et al. (1998), a Delphi study should have around 15 participants as diminishing returns suggests any more will have little improvement in reliability. The first round uses an open-ended question or series of questions to assemble feedback on a selected topic. Then, an iterative process of completing the same items and receiving feedback about how the individual and group responded is conducted. In subsequent rounds, participants use ranking and rating scales calculated by the researcher to consider their responses and prioritize items (Davis & Alexander, 2009). Rounds continue as needed to reach consensus, which is established by the researcher at the start of the study.

The Delphi technique is a way to explore issues, predict the future, and plan. Originally developed for business and government prediction, today the Delphi technique is widely used in education fields and considered one of the most beneficial forecasting measures (Nworie, 2011). The driving force for using Delphi is the notion that "collective opinions of expert panelists are of richer quality than the limited view of an individual" (Nworie, 2011). The results of this study will establish ways STEM education concepts can be integrated into the family and consumer sciences nutrition and food science career pathway according to an expert panel. These results can be used for future planning, policy formulation, decision-making and development of family and consumer sciences career pathways. Therefore, the Delphi technique can be used to develop the relationship between an integrated STEM education and family and consumer sciences nutrition and food science curriculum.

Through multiple rounds of surveys and controlled feedback provided by the researcher, the Delphi survey seeks to achieve consensus of thought among panel members for the selected topic or question (Davis & Alexander, 2009). The Delphi survey is practical for interest areas with little known information or thought and subjective issues. Despite the limitations, the advantages meet the needs for this study. Therefore, rendering Delphi appropriate for the topic of this proposed study as there is little information on STEM education integration into the family and consumer sciences career pathways. Given all the aforementioned information about STEM education integration and the family and consumer sciences career pathway of nutrition and food science, the Delphi survey is the most applicable and appropriate research method for the proposed study.

The Delphi Technique in Family and Consumer Sciences Research

Little research has been conducted using the Delphi technique in family and consumer sciences. To date, the review of literature shows only eight studies. These studies spanned a 20 year period and included several areas of family and consumer sciences.

Issues affecting home economics in the twenty-first century were explored by Wooldridge in 1986. Wooldridge conducted a three round Delphi study identifying 94 items, 27 of which could be considered trends. Seventy-five home economics leaders participated in this study. To tabulate results between rounds, Wooldridge used means and standard deviations. The items were then grouped by the researcher into two categories: issues or trends. A model was used to illustrate the dynamics of the interaction among family, society, and the profession. Wooldridge believed that the results of her study would be important for planning future issues in home economics (1986).

There have been two Delphi studies on identifying competencies in family and consumer sciences. In 1985, Eves completed a four round Delphi study determining necessary competencies and appropriate learning experiences for home economics teacher educators. Eves study had 77 home economics educators who participated, finding 114 competencies and learning experiences. Canterino (1990) study was conducted to identify necessary competencies and learning experiences for hospitality educators. A three round Delphi study, with 56 nominated hospitality educators, generated 90 competencies and learning experiences (Canterino, 1990). According to Canterino (1990), the results postulated 14 competencies and six learning experiences were identified as necessary by meeting the established criteria.

In 1996, Combs and Hall conducted a Delphi study on postsecondary and adult family and consumer sciences education in the year 2010. The purpose of their study was to predict future priorities of adult family and consumer science education programs (Combs & Hall, 1996). Their study consisted of 27 participants, referred to as panel members, and underwent three rounds. The panel members had 43 items to rank on a Likert-type scale and consensus was defined at 75% agreement (Combs & Hall, 1996). Based on their results, Combs and Hall (1996) found the Delphi technique to be successful and recommend using the Delphi technique in family and consumer sciences research.

Two years after the Combs and Hall study, a Delphi study was done in family and consumer sciences to determine the importance of employability skills in secondary child care programs (Couch, Felstehausen, & Webber, 1998). Couch et al. (1998) used a three round Delphi survey, with 48 participants, to reach consensus of the perceived importance of selected employability skills for secondary students who are preparing to enter positions in childcare occupations. After completion of the third round, consensus was achieved for 99.6% of the items with consensus being defined as 70% of agreement (Couch et al., 1998). One aspect of the Delphi technique Couch et al. (1998) found to be a strength for the Delphi was the use of a small group of experts is required. The Delphi technique proved to be appropriate for their study.

A decade later, Davis and Alexander (2009) conducted a three round Delphi study to identify topics that should be the priority of future research in family and consumer sciences. Davis and Alexander (2009) had 21 participants who were able to identify thirteen topics. The Delphi technique in this study was effective and the researchers were able to identify priorities (Davis & Alexander, 2009). Furthermore, the Delphi technique was useful for this study as the researchers were able to use experts geographically dispersed.

More recently in 2010, Davis completed a Delphi study to determine priorities for family and consumer science education programs. Davis used the 2008 membership roster for the National Association of Teacher Educators for Family and Consumer Science (NATEFACS) to compile her list of experts; of the 164 she contacted, forty participated in the study for all three rounds. Her findings determined the Delphi method to be an effective approach for her study and for developing consensus on a given topic. However, Davis notes future studies should also include content experts and curriculum leaders to reduce the possibility of response bias. Davis used descriptive statistics to analyze her results; such as the mean, percent of agreement, and IQR. In conclusion, Davis (2010) was able to determine seven high-ranking teacher education priorities for family and consumer science teacher educators.

Laing-Keen (2010) explored core principles and test item development for advanced high school and introductory university level food science courses. According to Laing-Keen (2010), all courses supported by the 2006 Carl D. Perkins Act are required to follow state and national standards, and conduct evaluations for accountability. However, in Indiana, a broad-based assessment to measure student performance is missing. The researcher conducted a Delphi study, asking participants four questions regarding core principals and evaluations for the food science courses. The results of the study identified ten core principles with 85 corresponding performance indicators (Laing-Keen, 2010). Additionally the Delphi participants reached consensus on 158 standards-based test items to be used on assessments.

CHAPTER 3

Method

This chapter begins by providing the purpose of the study and research questions. The remainder of the chapter described the method used in this study and organized into the following sections: (a) research design, (b) participants, (c) instrumentation, (d) procedure, and (e) data analysis.

Purpose Statement

The purpose of this Delphi study was to project the integration and contribution of science, technology, engineering, and mathematics (STEM) education concepts into the nutrition and food science career pathway curriculum at the secondary level (grades 9-12). STEM education concepts are defined as *abilities, skills, and knowledge* associated with the disciplines of science, technology, engineering and/or mathematics and needed to pursue a related career (Rennie, Venville & Wallace, 2012; Shatkin, 2009). The nutrition and food science career pathway is one of three pathways in the family and consumer sciences education program in Georgia and many other states. The nutrition and food science career pathway includes three courses: Food, Nutrition, and Wellness; Food and Nutrition through the Lifespan; and Food Science. The food and nutrition through the lifespan and food science courses are accepted as the fourth science requirement for graduation. The aforementioned statement underscores the importance and the contribution of family and consumer sciences to the overall education of students by integrating the STEM education concepts into the nutrition and food science pathway curriculum.

This study used an expert panel from two major learned societies, the Association of Career and Technical Education (ACTE) and the American Association of Family and Consumer Sciences (AAFCS). Teacher educators and administrators were used from the Family and Consumer Sciences Division and STEM educators in the Engineering and Technology Division of ACTE (edTED). Foods and nutrition professionals were used from the Nutrition, Health and Management, and Hospitality Management Division of AAFCS. The panel was selected through nominations from members of the aforementioned organizations. Using experts from the different sectors in this study strengthens the results as it will have direct implications for secondary teachers and the foods and nutrition pathway; a varying group will offer various perspectives (Linstone & Turoff, 1979).

Results would be used to generate discussion among family and consumer sciences educators for future planning and development of the nutrition and food science career pathway curriculum to enhance students' opportunities for STEM-related careers.

Specific research questions included:

1. With respect to skills, abilities, and knowledge, what STEM education concepts should be included in the nutrition and food science career pathway curriculum?
2. What should family and consumer sciences education professionals do to integrate STEM education concepts (skills, abilities, and knowledge associated with the disciplines of science, technology, engineering, and mathematics) into the nutrition and food science career pathway curriculum?
3. What should be some contributions of integrating STEM education concepts (skills, abilities, and knowledge associated with the disciplines of science, technology, engineering, and

mathematics) into the family and consumer sciences education curriculum generally and the nutrition and food science career pathway specifically?

Design

The Delphi research technique was used for this research study to gather expert opinion on the integration of STEM education concepts (science, technology, engineering, and mathematics) into the nutrition and food sciences career pathway curriculum for future planning and development in family and consumer sciences education. The RAND Corporation developed the Delphi survey in the early 1950s to predict the future defenses needs of the U.S. military and to improve the decision-making skills of individuals identified as knowledgeable (Dalkey, 1969; Linstone & Turloff, 1975). Today, Delphi is typically used to make predictions or gain consensus among a group of people on a subjective thought (Couch, Felstehausen, & Webber, 1998). Delphi was selected for this study so that individuals with expertise in family and consumer sciences education, nutrition and food science, and STEM education could project integration of STEM education concepts into the nutrition and food science curriculum; this could potentially increase interest in STEM-related careers.

The Delphi method uses knowledgeable participants in geographically dispersed areas to respond collectively to questions or issues relying on their expertise. Participants in a Delphi study are typically referred to as expert panelists. Participants in a Delphi study should be experts in their fields of study and able to use their knowledge to provide informed views or opinions on presented questions (Baumfield, Conroy, Davis, & Lundie, 2012; Nworie, 2011). Meyer and Booker (1990) define an expert as one who is knowledgeable in detail of a particular field. For one to be considered an expert, a certain level of knowledge, education, and experience is required. For instance, experts interact and participate in different sectors of the subject, such as leadership roles, teaching, and/or research (Baumfield et al., 2012). Experts typically have practical, formal, and metacognitive knowledge of their field and should be able to take their knowledge and successfully apply it in practice (Happo & Määttä, 2011). Often, knowledge accrues through life experiences and continued work in the field. Experts should be well respected in the field for greater credibility to the study (Meyer & Booker, 1990). An examination of the possible participants' level of work such as teaching experience, publications and research and professional organizations (Davis & Alexander, 2009) compared to peers to determine if the expert has produced concrete results has also been a useful criterion (Davis & Alexander; 2009; Davis, 2010; Ericsson, Prietula, & Cokely, 2007). However, there are limitations for using almost any given criteria.

The Delphi technique is a survey study consisting of multiple (iterative) questionnaire rounds designed to reach consensus among a selected group of experts on a given topic. Consensus is determined in a study when a certain percentage of votes of rankings fall within a predetermined range (Hsu & Sandford, 2007). Consensus indicates that an established percent of the participants in the study are in agreement on major themes or items. Most Delphi studies end at a predetermined number of rounds (Baumfield et al., 2012). A review of 40 dissertations using the Delphi technique revealed that three rounds were most often used (Skulmoski, Hartman, & Krahn, 2007). The first round of a Delphi study uses an open-ended question or series of questions to gather feedback on a selected topic. After the first round is completed, the open-ended responses are collapsed and categorized into statements and formulated into a Likert-type scale constructed by the researcher. Then, an iterative/repetitive process of completing the same items and receiving feedback about how an individual and the group responded is conducted, consisting of two or three rounds depending on how many rounds the researcher has chosen.

Subsequent rounds continue as needed to reach a level of consensus, which is established by the researcher at the outset of the study.

There are several advantages for using the Delphi technique. The advantages to using the Delphi survey are anonymous responses, controlled feedback between rounds, and shared statistical group responses (Dalkey, 1969; Linstone & Turloff, 1975). With anonymity, the chance of bias or bandwagon effects, dominating personalities, and group pressure are minimized. While the participants remain anonymous to each other, the researcher has access to who is participating and on what rounds. Delphi participants are not required to meet face-to-face, but are able to proceed at their own pace without the influence of others. The researcher provides feedback to respondents through a sequence of rounds and between rounds, a summary of results is calculated from the previous round results. Items are compiled and sent back to participants to consider their earlier responses given or based on new information about group tendencies. In this manner, all members are equally represented; the statistical group response reduces group pressures and allows each member to be represented (Dalkey, 1969). Participants view newly calculated descriptive data and are encouraged to make revisions to their responses based on the feedback they receive (Davis & Alexander, 2009). The Delphi survey, when well designed, requires less effort than meeting face-to-face from participants and is financially more affordable due to no travel costs. Therefore, Delphi is practical when face-to-face methods are not realistic and anonymity creates a shared responsibility among participants producing more accurate results (Couch et al., 1998).

While the Delphi survey is very useful for gaining consensus among knowledgeable people, limitations to the technique exist. The Delphi survey relies on participants remaining interested in the study, but all participants may not maintain a level of interest to complete all rounds (Davis & Alexander, 2009; Hsu & Sandford, 2007; Lambrecht, 2007). The Delphi survey does not produce immediate results as a large amount of time is required from participants to complete the three or more rounds of survey administration (Linstone & Turloff, 1975; Skulmoski et al., 2007; Stimpson, 2010). In addition, participants may experience boredom and fatigue from multiple rounds (Combs & Hall, 1994). Therefore, some Delphi studies will end upon the completion of Round 3 to limit saturation (Baumfield et al., 2012; Skulmoski et al., 2007). The Delphi survey is practical for interest areas with little known information or thought and subjective issues, making it appropriate for the topic of this study, as there is little research on the integration of STEM education concepts into family and consumer sciences generally, and the nutrition and food science career pathway curriculum, specifically. Additionally, this method is applicable for projecting future directions of a research topic. Given these facts and circumstances, the Delphi survey is the most applicable and appropriate research method for this research study.

Participants

A purposeful sampling technique known as snowballing sampling was used to select the panel for this study. Snowball sampling involves asking individuals with a certain expertise or characteristic to identify others with similar traits (Fraenkel, Wallen, & Hyun, 2011; Gall, Borg, & Gall, 2007). The need for an expert panel is the crux of the consensus technique for this study. Previous Delphi studies used key criteria such as expertise in the subject, education, research experience in the field, willingness to participate, and communication skills (Baumfield et al., 2012; Skulmoski et al., 2007; Stimpson, 2010). The criteria for this study, selection process, and participant descriptions are provided in the following paragraphs.

The criteria used in this study were the following. First, an individual was nominated by leaders in a professional organization as one who possesses knowledge and experience in STEM education, family and consumer sciences education (teachers, teacher educators, and/or administrators), or nutrition and food science. Members of professional organizations were asked to judge a nominee's knowledge and experience based on area of certification, perceived expertise in the topic, teaching or training, publication and research, contributions to the discipline, and record of service to the profession. Second, the nominee's capacity and willingness to participate in the study was ascertained by inquiring on the letter of invitation (see Appendix A). The potential panelist time to participate in the study was presented on the letter of invitation. These criteria were adapted from Skulmoski et al. (2007).

Participants Selection

To select members of the Delphi panel, nomination letters (see Appendix B) were sent to 175 members of the four following professional organizations: National Association of Teacher Educators for Family and Consumer Sciences (NATEFACS), the National Association of State Administrators of Family and Consumer Sciences (NASAFCS), the Engineering and Technology Education Division of the Association of Career and Technical Education (ACTE), and the Nutrition, Health and Food Management, and Hospitality Management Community of the American Association of Family and Consumer Sciences (AAFCS). These members were asked to identify at least five individuals in their profession with expertise in nutrition and food science, family and consumer sciences education, or STEM education. Therefore, the panel of experts for this study was composed of family and consumer sciences teacher educators, administrators, and secondary teachers, STEM education professionals, and nutrition and food science professionals. These experts in this study come from different areas including administration, secondary education, higher education, and industry and business.

A typical Delphi survey includes 15-30 participants (Couch et al., 1998; Dalkey, 1969). Some researchers maintain that 10 to 15 panelists are sufficient if the background of participants is homogeneous (Skulmoski et al., 2007; Stimpson, 2010). However, heterogeneous groups need more people to adequately represent each area in the study's sector (Hsu & Sandford, 2007). This study had a heterogeneous group consisting of four specializations. As a result, 20 to 40 participants were sought for this study, representing the upper recommendations of panelists for a heterogeneous group. Consistent with the composition and rationale for the panel in Wicklein and Rojewski (1999), the panel in this study was purposefully weighted heavily in the direction of family and consumers sciences professionals because of their knowledge and understanding of the foods and nutrition concepts and curricula. Of those who responded to the descriptive characteristic questions, 14 participants listed current employment from an education background while only 2 listed other. Additionally, there were substantially more female participants than male participants that agreed to participate in this study. According to Murphy et al. (1998), only 15 participants should be maintained throughout the completion of the study as diminishing returns suggests any more will have little improvement in reliability. An explanation of each of the four groups included in this study will be provided in the following paragraphs.

The Family and Consumer Sciences (FACS) Division of the Association for Career and Technical Education (ACTE) mission is to improve and develop family and consumer education and advance the purposes of ACTE (Association for Career and Technical Education, 2014). Additionally, the FACS Division goal is to prepare students for life and careers in family and consumer sciences through development of a skill set and behaviors important to family and consumer sciences (Association for Career and Technical Education, 2014). The administrators from the ACTE FACS Division, National Association of State Administrators of Family and Consumer Sciences (NASAFACS), are one part of the expert panelists used in this study. The family and consumer sciences focus is on families, works, and interrelationships (National Association of State Administrators of Family and Consumer Sciences, n.d.). Therefore the NASAFACS administrators contributed expert opinion in the areas of FACS careers opportunities and professional relationships. Moreover, the administrators are making the decisions on future directions of family and consumer sciences and work with secondary teachers in the state. Administrators were asked to nominate their colleagues and secondary teachers from the nutrition and food science career pathway to participate in this study.

Family and consumer science teacher educators were invited to participate in this study and also nominate secondary teachers in the nutrition and food science career pathway. The National Association of Teacher Educators for Family and Consumer Sciences (NATEFACS) is a national organization with the mission of strengthening teacher education in family and consumer sciences. The NATEFACS participants provided expert opinion on the practice of teaching family and consumer sciences. Teacher educators are also experts in the family and consumer sciences curriculum, including nutrition and food science.

STEM educators from the Engineering and Technology Education Division of the Association of Career and Technical Education (ACTE) were invited to participate in this study. The Engineering and Technology Education Division (eTED) is aligned with the STEM Career Cluster and will therefore provide expert opinion from a STEM perspective. Participants from the eTED Division include secondary teachers, district and state supervisors, and teacher educators. The purpose of eTED is to advance career and technical education through an enhanced secondary engineering and technology education (Association for Career and Technical Education, 2014). eTED works with other divisions of ACTE, such as family and consumer science, to strengthen career and technical education on the national level.

Nutrition, Health and Food Management, and Hospitality Management Community (NHFM) of the American Association of Family and Consumer Sciences (AAFCS) mission is to support nutrition, health, and food management of individuals, families, and communities. Additionally the goal is to provide leadership to the field of food management (AAFCS, n.d.). The Nutrition, Health, and Food Management (NHFM) provided a membership list to invite experts for participation in this study. The participants provided expert thought from the perspective of working with individuals, families, and communities in the NHFM industries. Foods and nutrition professionals are employed in a variety of settings including food chemistry, processing and packaging engineers, dietician, and restaurant manager to name a few.

With the Delphi technique, expert panelists are responsible for providing knowledgeable responses to forecast future development and planning. Furthermore, it is imperative to use appropriate experts for this study. Participants for this study came from practitioners and researchers in the field of family and consumer sciences education, STEM education, and foods and nutrition business and industry. Using participants from different areas with similar but different responsibilities will allow for a variety of responses. The body of knowledge in family and consumer sciences continues to evolve to meet the current needs of society (Nickols, Ralston, Anderson, Browne, Schroeder, & Thomas, 2009). Meyer and Booker (1990) advised using diverse experts to gain multiple viewpoints. A diverse group of experts are more likely to answer the question or problem in different ways; responses varied by job description and professional role.

The participants for this study included K-12 classroom teachers, administrators, teacher educators, State agency workers, and STEM professionals. Additionally, there was some variation in participant age, degree, gender, and ethnicity. As outlined in Table 1, this study weighed heavily in female participants, and those from an education employment background. However, participants weighed heavily in one direction for a study are able to better provide expertise in their given field (Wicklein & Rojewski, 1999). Therefore, the chosen participants for this study represent the best possible group to use for the scope of this study. A description is in Table 1.

Table 1

Descriptive Characteristics of Panel Members

Characteristic	N	%
Current Employment		
Classroom K-12	7	43.75
Administrator K-12	1	6.25
Teacher Educator	4	25
State Education Agency	1	6.25
STEM Educator	1	6.25
Other	2	12.5
Gender		
Male	2	12.5
Female	14	87.5
Ethnicity		
Caucasian/White	13	81.25
African American	1	6.25
Latino	0	0
Advanced Degree		
Master’s	8	50
Doctoral	5	31.25
Age (Years)		
25 to 34	0	0
35 to 44	0	0
45 to 54	2	12.5
55 to 64	6	37.5
65 to 74	2	12.5

Note. Four participants did not complete the characteristics portion of the survey.

Instrumentation

A Delphi survey was used to collect data for this study. Therefore, to develop the questionnaire, the researcher began with identifying items via responses from the five open-ended questions developed by the researcher and committee chair, provided to participants in Round 1 (see Appendix C). The researcher then consolidated the response items from Round 1 to a final list, eliminating duplicates. The items were formatted into a questionnaire for participants to rate in the subsequent rounds.

The five open-ended questions provided to participants are as follows:

1. Using the academic standards and concepts provided below in Table 2, list as many *skills*, *abilities*, and *knowledge* associated with science that should be included in the nutrition and food science career pathway at the secondary level to pursue a related career. There is no need to rank items; you may list more if desired.
2. Using the academic standards and concepts provided below in Table 3, list as many *skills*, *abilities*, and *knowledge* associated with mathematics that should be included in the nutrition and food science career pathway at the secondary level to pursue a related career. There is no need to rank items; you may list more if desired.
3. Using the academic standards and concepts provided below in Table 4, list as many skills, abilities, and knowledge associated with technology education that should be included in the nutrition and food science career pathway at the secondary level to pursue a related career. There is no need to rank items; you may list more if desired.
4. Using the academic standards and concepts provided below in Table 5, list as many *skills*, *abilities*, and *knowledge* associated with engineering that should be included in the nutrition and

food science career pathway at the secondary level to pursue a related career. There is no need to rank items; you may list more if desired.

5. What are some suggestions (strategies, approaches, ideas) that the family and consumer sciences education profession can do to integrate STEM education concepts into the nutrition and food science career pathway at the secondary level?

To rate the items for Round 2, a 4-point Likert-type rating scale was used. Likert scales are commonly used to efficiently gain expert thought on a given topic (Hartley & MacLean, 2006). The Likert scale features statements to which participants select their level of agreement or disagreement. An even numbered response set was chosen because this forces participants to commit to a clear orientation toward each item; whereas odd numbered scales can lead to neutrality (Brown, 2000) and do not designate consensus. Thus, requiring participants to have a definite opinion will minimize the chance of inaccurate responses. The scale was anchored as follows: Strongly agree = 4, Agree = 3, Disagree = 2, Strongly disagree = 1. Brief descriptors were chosen because Hartley and MacLean (2006) found that Likert scales with self-descriptive statements (e.g., "I have as much energy as ever.") had lower response rates when compared to brief descriptors (e.g., never).

Pilot Test

The Round 1 open-ended questions underwent pilot testing prior to the start of the round. The purpose of pilot testing was to make certain the questionnaire produce responses and to ensure results will be able to be analyzed as anticipated (Buckingham & Saunders, 2004). An advisory panel was used consisting of three qualified individuals who are in the Workforce Education doctoral program at the University of Georgia. All individuals in the mock panel received identical questionnaires. The mock panel was asked to check for validity issues, clarity (in items and instructions), and length of time for completion. The panel was asked to address a series of questions on the directions, research questions, letter of invitation, nomination letter, e-mail contact, and cover letter. Participants' feedback provided valuable contributions to strengthen and refine the study. A pilot study was be used to make adjustments and work out any procedural problems (Skulmoski et al., 2007). Additionally, pilot testing is beneficial for new researchers who may underestimate the time it will take panelist to fully respond to a Delphi survey.

Procedure

The Institutional Review Board (IRB) approval was sought from the University of Georgia. The University of Georgia Office of the Vice President for Research requires that IRB approval is granted prior to the start of gathering research data.

Once UGA IRB approval was obtained, the data method for this study followed procedures established by previous Delphi studies (Combs; 1994; Davis, 2010; Flanders, 1988; Stimpson, 2010). This study was conducted via Qualtrics, a web-based survey program whereby users are able to collect and transfer data to statistical package. Nowadays, most Delphi studies are completed via electronic mail (Kesten & Lambrecht, 2010; Skulmoski et al., 2007). One of the biggest benefit to electronic mail is the quick turn-around rate, which helps keep enthusiasm and participation high (Skulmoski et al., 2007). Electronic mail eliminates the tedious task of transcription. However, studies have shown web-based only surveys had a lower response rate when compared to postal only (Millar & Dillman, 2011).

For this study, a three-round Delphi survey was used. The researcher anticipated consensus will be met in three rounds and according to Lambrecht (2007), three rounds are typically enough for consensus to be achieved. Furthermore, this is most common amongst

Delphi studies (Chia-Chien & Sandford, 2007; Stimpson, 2010; Skulmoski e al., 2007). Additionally, subsequent rounds can lead to participant and research fatigue and attrition (Nworie, 2011).

An initial e-mail containing the nomination letter (see Appendix B) was sent to the 175 members of the four following professional organizations: National Association of Teacher Educators for Family and Consumer Sciences (NATEFACS), the National Association of State Administrators of Family and Consumer Sciences (NASAFCS), the Engineering and Technology Education Division of the Association of Career and Technical Education (ACTE), and the Nutrition, Health and Food Management, and Hospitality Management Community of the American Association of Family and Consumer Sciences (AAFCS). The nomination letter asked members of the professional organization to provide the names of at least five individuals that they feel could serve on a panel on integrating STEM education abilities, knowledge, and skills into the nutrition and food science career pathway. These members were asked to submit their nominations in seven days. After nominations were received, the panel of experts was compiled giving attention to including individuals from the four sectors mentioned above. A letter of invitation was sent to nominees to ensure their willingness and commitment to participate in this study (see Appendix B).

In preparation for data collection, the panelists were given a numerical code to identify the respondent to the researcher. This procedure helped the researcher report findings to participants between rounds. Data collection will begin.

Delphi Round 1

Round 1 began with a cover letter that provides an explanation of the study, its importance to the field, obligations of the participants, time frame and commitment, and assurances of confidentiality sent to the panel of experts via Qualtrics. Round 1 presented the initial open-ended qualitative research questions to participants and solicit their responses. A qualitative, open-ended question is designed to generate a broad range of written responses (Smyth, Dillman, Christian, & McBride, 2009). Copies of the cover letter and the first-round qualitative questions are in Appendices E and F.

In the first-round, participants were provided with a description and standards of the three courses in the nutrition and food science career pathway and asked in questions one through four to list at least five STEM education concepts (skills, abilities, and knowledge associated with the science, technology, engineering, and mathematics disciplines) that should be included in the aforementioned pathway curriculum. In question five, participants were asked, "What are some suggestions (strategies, approaches, and ideas) that the family and consumer sciences education profession can do to integrate STEM education concepts into the nutrition and food science career pathway at the secondary level?"

Based on Round 1 responses, a questionnaire was developed into a Likert-type scale using the responses identified by the panel. The researcher collected the responses provided in Round 1 from Qualtrics; consolidated the items to a final list that was presented to the participants as a questionnaire in the subsequent rounds. Wicklein, Smith, and Kim (2009) sent Round 1 data to an advisory panel to form the Round 2 instrument. For this study, an advisory panel of three persons reviewed the Round 1 responses to establish content validity. Additionally the panel reviewed Round 1 responses to categorize the data into a list of unique items that created the subscales. Like responses or frequently occurring responses were consolidated based on STEM education concepts to form a succinct list and non-related or incomplete responses were eliminated.

As projected, the questionnaire was developed into five sub-scales. There was a sub-scale for each of the four fields representing STEM education concepts of skills, abilities, and knowledge. The researcher also created a sub-scale for the responses on integration and contribution of STEM education concepts to family and consumer sciences called strategies and recommendations. This facilitated the organization of the concepts, data analysis, reporting of findings, and ultimately the discussion. After the instrument was developed, the advisory panel reviewed the instrument. A partially constructed questionnaire is provided in Appendix E as a precursor and examination.

Delphi Round 2

Participants completed the Round 2 questionnaire via Qualtrics.com. Round 2 included the most frequently occurring responses from Round 1 that were formulated into statements by the researcher and categorized as STEM education abilities, STEM education knowledge, or STEM education skills for each of the four STEM disciplines and the strategies and recommendations for the integration of concepts, and contribution of concepts to family and consumer sciences. Round 2 participants were asked to review the compiled responses from Round 1 and rate the degree of agreement of each item using a 4-point Likert-type scale. Likert-type scales are generally felt to be easily understood by participants (Linstone & Turoff, 1979). Instructions and an example will be included for participants to review.

Responses from Round 2 were coded and entered into SPSS. Round 2 results were calculated using descriptive statistics, means and standard deviations, to determine the ratings of items. Means and standard deviations are appropriate to share with participants because they provide a broad description and summary of data. Participants received the group mean, individual answer, and options for no change or to provide a new answer for each response from Round 2 in the Round 3 questionnaire.

Delphi Round 3

The mean score and standard deviation were computed for each item in Round 2. The statements in Round 3 were ranked in descending order according to agreement based on means, standard deviations, and composite scores from the previous round (Round 2). The researcher provided all participants with the descriptive statistics results from Round 2. Participants were then asked to review the items and revise their opinion if necessary based on the data provided. Participants also had the chance to comment and provide feedback. Final results were shared with the panel.

Participants had two weeks to complete each round (Dillman, Smyth, & Christian, 2009). To encourage participation, prior to the close of each round an e-mail reminder was sent to participants who participated in previous rounds but had not completed the current round. The study took approximately 6 months to complete Rounds 1 through 3. A description of the timeframe is in Table 2.

Table 2

Timeframe of Study

Semester	Data Collection	Participants
Fall 2014, October	Request IRB approval	Researcher
Spring 2015, January	Identify participants who will become the expert panelists for this study	Researcher
Spring 2015, January	Round 1 questionnaire constructed including research question	Researcher
Spring 2015, January	Invitation packet prepared containing invitation letter, consent form, and clarification of terms	Researcher
Spring 2015, January	E-mail invitation to participants to complete this study	Members of Professional Organizations
Spring 2015, April	Round 1 questionnaire, via online survey	Expert panelists
Spring 2015, April	E-mail reminder for Round 1	Expert panelists
Spring 2015, May	Round 1 responses consolidated to itemized list	Researcher
Spring 2015, March	Validity and reliability established	Researcher , pilot study group
Summer 2015, June	Round 2 questionnaire, via online survey	Expert panelists
Summer 2015, July	E-mail reminder for Round 2	Expert panelists
Summer 2015, August	Round 2 data entered in SPSS	Researcher
Fall 2015, September	Round 3 questionnaire developed	Researcher
Fall 2015, October	Round 3 questionnaire, via online survey	Expert panelists
Fall 2015, October	E-mail reminder for Round 3	Expert panelists
Fall 2015, November	Round 3 data checked for consensus	Researcher

Data Analysis

Most Delphi studies use both qualitative and quantitative research methods. For this study, qualitative research methods were used to identify the major themes from the open-ended questions of Round 1. Both descriptive and inferential statistics were used to analyze data for Round 2 and Round 3 of this study. Means, standard deviations, medians, and interquartile ranges were calculated. Also, the composite score was computed to rank each item. A description of each data analysis is in the following paragraphs.

Measures of central tendency (mean, median, and mode) and dispersion (standard deviation, interquartile range) are the descriptive statistics used for measuring participants' and group responses and to indicate when consensus was achieved. According to Hsu and Sandford (2007), the median and mode would be favored with samples of a reasonable size. Furthermore, the median is preferred over the mean (Gordon, 1994; Keeney, Hasson, & McKenna, 2006) as the measure of central tendency. Dalkey (1969) found the median to be effective and stronger than true answers. The interquartile range (IQR) is preferred for representing the spread or variance (Gordon, 1994; Keeney et al., 2006). The IQR is calculated from taking the difference between the third and first quartiles representing the spread of the middle (50%) of the scores. A large IQR score represents more variability for a particular item. To interpret the IQR findings, statements with an IQR of 0.0 are determined to have very high consensus, an IQR $\leq$ (less than) 1.0 are determined to have consensus, and an IQR > (greater than) 1.0 little or no consensus (Heather, Dallolio, Hutchings, Kaner, & White, 2004). Previous Delphi studies (Dalkey, 1967; Murphy et al., 1998) found as long as there are eight or more participants in the study, the IQR and median have the advantage of robustness, as they are independent of extreme values and less sensitive to skew. Based on the recommendations from previous studies, the median and the interquartile range were used in this study as descriptive statistics help determine consensus.

The research varies on the suggested consensus level from a minimum of 51% agreement among respondents to 80% agreement (Davis, 2010). Prior Delphi studies in family and consumer sciences education have defined acceptable consensus from 62.5% (Davis & Alexander, 2009) to 75% (Combs & Hall, 1994) of item agreement. For this study consensus is defined as 62.5% of agreement on each item. This researcher chose a more liberal consensus level of 62.5% of agreement in order to achieve a wider range of responses as this is a research area with little known information. According to Stimpson (2010), when there is a research area with little known information, a wider range of results is desired and needed. Therefore, consensus is reached in this study when the following criteria are satisfied: 62.5% of the respondents fall within the median of 3 or higher on a 4-point scale and the IQR is less than or equal to 1.

The composite score was calculated for each item by applying the numerical score to the questionnaire scale as indicated above. The number of items on the questionnaire was scored by the participants using four-point Likert-type scale. The categories range from Strongly agree = 4, Agree = 3, Disagree = 2, Strongly disagree = 1. The composite score was calculated for each individual item by assigning a value to each response. For example, if 30 participants rated an item Strongly Agree, that portion of the composite score would be 30 x 4 = 120. If five participants rated an item Agree, the score would be 5 x 3 = 15, while another 10 participants rated an item Disagree, giving a value of 10 x 2 = 20. The composite for that item would be 120 + 15 + 20 = 155. The composite scores were calculated on the final round of the study since the final round is considered the most accurate round and most valuable to the study.

The statistical procedures performed on the data in the study determined whether or not participants change their opinions significantly from one round to the next. The medians and interquartile ranges and means and standard deviations were calculated for each item in Rounds 2 and 3. However, only the means and standard deviations were reported to participants whereas all descriptive statistics will be reported in the findings section for this work.

The medians and interquartile ranges were used to check for convergence of opinion and round to round stability. The means and standard deviations were used for their greater precision and report to participants. The planned or proposed composition of the Delphi panel lends itself more likely to agreement rather than disagreement. Therefore and based on previous research, the medians and interquartile ranges were more appropriate measure of consensus.

Demographic data was collected in Round 1 and provided a description of the panel of experts. Information regarding job description, sex, age, race, educational, and specific profession and related activities will be collected, see Table 1. Table 3 shows the data analyses for each round in this study.

Table 3

Data Analyses for Delphi Rounds

Rounds	Data Analysis	Rationale
Round 1	Item responses	Create scales
	Research questions	Item responses Grouping like responses
Round 2	Mean and standard deviation	Measure central tendency and variance
	Median and interquartile range	Measure central tendency and variance
	Composite score	Item rank
Round 3	Mean and standard deviation	Measure central tendency and variance
	Median and interquartile range	Measure central tendency and variance
	Composite score	Item rank

CHAPTER 4

Data Analysis

The purpose of this study was to project what should be included in the integration and contribution of family and consumer science nutrition and food pathway courses with STEM (Science, technology, engineering, and mathematics) concepts at the secondary level. The objectives of this study were accomplished by using a panel of experts from professional organizations in family and consumer science and those who possess knowledge and experience in the STEM fields. This Delphi study used both qualitative and quantitative research. This chapter presents the results of this Delphi study by rounds.

The Delphi survey technique was used for this study. Participants were selected by their peers using a nomination technique (see Appendix B). Participants were nominated from across the country. Twenty nominees agreed to participate in this study. Of the 20 participants, 20 (100%) participated in Round 1, 16(80%) in Round 2, and 15(75%) in Round 3. The study was carried out electronically through Qualtrics.

Round 1

The first round of the Delphi study began after IRB approval (see Appendix F). A pilot study was conducted to check for validity. Upon completion of the pilot study, the Round 1 instrument was formatted in Qualtrics. Round 1 Delphi participants were invited via email through Qualtrics and presented with an explanation cover letter (see Appendix D). The participants were asked in Round 1 to respond to five open-ended questions on an electronic response form (see Appendix C). By using open-ended questions, participants were able to provide a broad range of responses they best feel represent the field and research purpose

(Smyth, Dillman, Christian, & McBride, 2009). All 20 participants completed Round 1 for a participation rate of 100%.

Round 2

Round 1 statements were consolidated based on frequently occurring statements and some restated for clarity. The Round 2 instrument was then created with 22 statements for question 1, 26 statements for question 2, 21 statements for question 3, 12 statements for question 4, and 20 statements for question 5. A 4-point Likert-type scale was used and anchored as follows: strongly agree (4); agree (3); disagree (2); strongly disagree (1). Participants were asked to review and rate each statement according to the scale. Sixteen participants completed Round 2 for a participation rate of 80%.

At the conclusion of Round 2, descriptive statistics were calculated for mean, standard deviation, interquartile range, and median (Table 1). To interpret the IQR findings, statements with an IQR of 0.0 are determined to have very high consensus, an IQR ≤ (less than) 1.0 are determined to have consensus, and an IQR > (greater than) 1.0 little or no consensus (Heather, Dallolio, Hutchings, Kaner, & White, 2004). This researcher chose a more liberal consensus level of 62.5% of agreement in order to achieve a wider range of responses as this is a research area with little known information. According to Stimpson (2010), when there is a research area with little known information, a wider range of results is desired and needed. Therefore, consensus is reached in this study when the following criteria are satisfied: 62.5% of the respondents fall within the median of 3 or higher on a 4-point scale and the IQR is less than or equal to 1. Tables 4 through 8 represent the descriptive statistics for Round 2.

Table 4

Round 2 Descriptive Statistics including the statement, mean, median, standard deviation, IQR, and composite score

Science Skills

1. Use standard safety practices for all classroom laboratory and field investigations.
Mean (4.00); Median (4.00); SD (.00); IQR (0); and CS (64)

2. Use tools and instruments for observing, measuring and manipulating scientific equipment and materials.
Mean (3.63); Median (4.00); SD (.50); IQR (1.00); and CS (58)

3. Identify and investigate problems scientifically.
Mean (3.69); Median (4.00); SD (.479); IQR (1.00); and CS (59)

4. Demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanation.
Mean (3.56); Median (4.00); SD (.512); IQR (1.00); and CS (57)

5. Analyze how scientific knowledge is developed.
Mean (3.44); Median (3.00); SD (.512); IQR (1.00); and CS 55

6. Collect and organize precise qualitative and quantitative data.
Mean (3.50); Median (4.00); SD (.632); IQR (1.00); and CS (56)

7. Evaluate the impact of food science on research, society, and the environment.
Mean (3.81); Median (4.00); SD (.403); IQR (0); and CS (61)

8. Distinguish and differentiate between scientific hypotheses and theories.
Mean (3.56); Median (4.00); SD (.512); IQR (1.00); and CS (57)

9. Communicate scientific investigations and information clearly.
Mean (3.63); Median (4.00); SD (.50); IQR (1.00); and CS (58)

10. Explain and recognize the value of collaboration and time management.
Mean (3.75); Median (4.00); SD (.447); IQR (1.00); and CS (60)

11. Work independently or collectively in differing roles.
Mean (3.53); Median (4.00); SD (.516); IQR (1.00); and CS (53)

12. Evaluate the importance of curiosity, honesty, openness and skepticism in science.
Mean (3.69); Median (4.00); SD (.479); IQR (1.00); and CS (59)

Science Abilities

1. Demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanation.
Mean (3.63); Median (4.00); SD (.50); IQR (1.00); and CS (58)

2. Plan and implement descriptive, comparative, and experimental investigations.
Mean (3.50); Median (3.50); SD (.516); IQR (1.00); and CS (56)

3. Apply scientific information extracted from various sources such as news, journal articles, and current events.
Mean (3.56); Median (4.00); SD (.512); IQR (1.00); and CS (57)

4. Present valid conclusions through methods such as lab reports, labeled diagrams, graphic organizers, journals and summaries.
Mean (3.69); Median (4.00); SD (.479); IQR (1.00); and CS (56)

5. Draw inferences based on data related to scientific investigations.
Mean (3.63); Median (4.00); SD (.50); IQR (1.00); and CS (58)

Science Knowledge

1. Understand important features of the process of scientific inquiry.
Mean (3.50); Median (3.50); SD (.516); IQR (1.00); and CS (56)

2. Explores the role of food additives, leavening agents, and processes of energy production in food.
Mean (3.81); Median (4.00); SD (.403); IQR (0); and CS (61)

3. Understand the effect of pH on pathogens related to food borne illnesses.
Mean (3.75); Median (4.00); SD (.447); IQR (.75); and CS (60)

4. Understand foodborne illnesses and how they are traced back to the source of contamination.
Mean (3.94); Median (4.00); SD (.25); IQR (.00); and CS (63)

5. Understand the digestive system and how age affects chemical absorption.
Mean (3.50); Median (3.50); SD (.52); IQR (1.00); and CS (56)

Table 5

Round 2 Descriptive Statistics including the statement, mean, median, standard deviation, IQR, and composite score

Technology Skills

1. Demonstrate employability and leadership skills required by business and industry.
Mean (3.63); Median (4.00); SD (.50); IQR (1.00); and CS (58)

2. Demonstrate and incorporate safe laboratory procedures in lab, shop, and field environments.
Mean (4.00); Median (4.00); SD (.00); IQR (0); and CS (64)

3. Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities.
Mean (3.94); Median (4.00); SD (.25); IQR (0); and CS (63)

4. Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products.
Mean (3.56); Median (4.00); SD (.51); IQR (1.00); and CS (57)

5. Exhibit critical thinking and problem solving skills to locate, analyze, and apply information in career planning and employment situations.
Mean (3.69); Median (4.00); SD (.48); IQR (1.00); and CS (59)

6. Given a group of food products, students should be able to properly design procedures for prepare certain nutritional meals that reflect technology changes through various historical time periods.
Mean (3.19); Median (3.00); SD (.83); IQR (1.75); and CS (51)

7. Create historical props or prototypes for nutritional displays and presentations.
Mean (3.06); Median (3.00); SD (.77); IQR (1.75); and CS (49)

8. Present a professional image through appearance, behavior, and language in the workplace and lab settings.
Mean (3.63); Median (4.00); SD (.50); IQR (1.00); and CS (58)

9. Demonstrate ethical and professional engineering behavior in the development and use of technology.
Mean (3.50); Median (4.00); SD (.63); IQR (1.00); and CS (56)

10. Work independently, interpret data, and apply teamwork skills.
Mean (3.56); Median (4.00); SD (.51); IQR (1.00); and CS (57)

Technology Abilities

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1. Use commercial and residential kitchen equipment, tools, and appliances.
Mean (3.69); Median (4.00); SD (.48); IQR (1.00); and CS (59)

2. Use appropriate technology to collect, record, manipulate, analyze, and report data.
Mean (3.94); Median (4.00); SD (.25); IQR (0); and CS (63)

3. Understand work area organization procedures and follow Standard Operating Procedures (SOP) when performing work.
Mean (3.81); Median (4.00); SD (.40); IQR (0); and CS (61)

4. Accurately interpret safety signs, symbols, and labels (Hazardous Communications).
Mean (4.00); Median (4.00); SD (.00); IQR (0); and CS (64)

5. Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products.
Mean (3.81); Median (4.00); SD (.40); IQR (0); and CS (61)

6. Create electronic presentations, displays, and portfolios for nutrition with the use of computer software.
Mean (3.75); Median (4.00); SD (.45); IQR (.75); and CS (60)

7. Apply the appropriate skill sets to be productive in a changing, technological, and diverse workplace to be able to work independently, interpret data, and apply teamwork skills.
Mean (3.81); Median (4.00); SD (.40); IQR (0); and CS (61)

Technology Knowledge

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1. Identify and describe the history of technology and its impact on society in the past, present, and future.
Mean (3.31); Median (3.00); SD (.48); IQR (1.00); and CS (53)

2. Identify key people who have influenced technological change.
Mean (3.25); Median (3.00); SD (.58); IQR (1.00); and CS (52)

3. Describe how technological advances impact nutrition, food processing and food safety.
Mean (3.69); Median (4.00); SD (.48); IQR (1.00); and CS (59)

4. Trace the development food and nutrition as a result of engineering and technology advancements.
Mean (3.60); Median (4.00); SD (.51); IQR (1.00); and CS (54)

5. Understand how mechanization has increased food supply.
Mean (3.69); Median (4.00); SD (.48); IQR (1.00); and CS (59)

6. Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products.
Mean (3.63); Median (4.00); SD (.50); IQR (1.00); and CS (58)

7. Attempt to predict the outcomes based on data collected in a project or experiment.
Mean (3.75); Median (4.00); SD (.45); IQR (.75); and CS (60)

8. Draw a conclusion when confronted with data or observations that focus on the observed plans, processes, or projects at hand.
Mean (3.75); Median (4.00); SD (.45); IQR (.75); and CS (60)

9. Evaluate the impact of science and society based on products and processes used in the real world for technological development.
Mean (3.5); Median (3.5); SD (.52); IQR (1.00); and CS (56)

Table 6

Round 2 Descriptive Statistics including the statement, mean, median, standard deviation, IQR, and composite score

Engineering Skills
1. Demonstrate and follow safety, health, and environmental standards related to the engineering workplace. Mean (3.63); Median (4.00); SD (.62); IQR (1.00); and CS (58)
2. Model employability skills and work readiness traits required for success in the engineering workplace including integrity, honesty, accountability, punctuality, time management, and respect for diversity. Mean (3.63); Median (4.00); SD (.62); IQR (1.00); and CS (58)
3. Design a solution to an engineering problem applying STEM principles. Mean (3.06); Median (3.00); SD (.85); IQR (1.00); and CS (49)
4. Create a display and prepare personal portfolio that represent characteristics of one's employability skills. Mean (3.63); Median (4.00); SD (.50); IQR (1.00); and CS (58)
5. Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities. Mean (3.81); Median (4.00); SD (.40); IQR (0); and CS (61)
6. Work independently, interpret data, and apply teamwork skills. Mean (3.69); Median (4.00); SD (.48); IQR (1.00); and CS (59)59

Engineering Abilities
1. Apply fundamental principles of the engineering design process. Mean (3.06); Median (3.00); SD (.93); IQR (1.75); and CS (49)
2. Describe the principal fields of engineering specializations (ex. aeronautical, automotive, chemical, civil, industrial, mechanical, computer software, electrical, and biomedical) and identify associated career tracks. Mean (2.94); Median (3.00); SD (1.00); IQR (1.75); and CS (47)
3. Identify the history of engineering and its impact on society in the past, present, and future. Mean (2.81); Median (3.00); SD (1.05); IQR (2.00); and CS (45)
4. Draw a conclusion when confronted with data or observations that focus on the observed plans, processes, or projects at hand. Mean (3.56); Median (4.00); SD (.51); IQR (1.00); and CS (57)

5. Finalize solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, qualitative, virtual, and physical means.
Mean (3.50); Median (4.00); SD (.63); IQR (1.00); and CS (56)

6. Participate in activities related to engineering career interests.
Mean (2.88); Median (3.00); SD (.81); IQR (.75); and CS (46)

7. Understand engineering knowledge and skills to analyze and suggest solutions to human societal problems.
Mean (3.19); Median (3.00); SD (.83); IQR (1.00); and CS (51)

8. Understand and apply the engineering design process through project based learning activities.
Mean (3.19); Median (3.00); SD (.83); IQR (1.00); and CS (51)

Engineering Knowledge

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1. Exhibit critical thinking and problem solving skills to locate, analyze, and apply information in career planning and employment situations.
Mean (3.62); Median (4.00); SD (.50); IQR (1.00); and CS (58)

2. Explain how the incorporation or lack of safety practices impact the economy and costs of safety in business and industry.
Mean (3.69); Median (4.00); SD (.48); IQR (1.00); and CS (59)

3. Explain how the creativity and systematic design approaches impact food and nutrition; consequently affect health of society's workforce.
Mean (3.62); Median (4.00); SD (.50); IQR (1.00); and CS (58)

4. Identify personal characteristics that employers are interested in prospective workers.
Mean (3.50); Median (4.00); SD (.63); IQR (1.00); and CS (56)

5. Understanding of Industrialized food systems and its impact on the nutritional health of the population.
Mean (3.56); Median (4.00); SD (.51); IQR 1.00(); and CS (57)

6. Research and prepare presentation of engineering careers that have direct impacts on development of food and nutrition disciplines.
Mean (3.38); Median (3.00); SD (.62); IQR (1.00); and CS (54)

7. Conduct technical research to develop possible solutions to a stated engineering problem.
Mean (3.25); Median (3.00); SD (.77); IQR (1.00); and CS (52)

Table 7

Round 2 Descriptive Statistics including the statement, mean, median, standard deviation, IQR, and composite score

Mathematics Skills

1. Communicate mathematically verbally, written, and electronically.
Mean (3.94); Median (4.00); SD (.25); IQR (0); and CS (63)

2. Solve mathematical problems based on field investigations and laboratory experiments.
Mean (3.81); Median (4.00); SD (.40); IQR (0); and CS (61)

3. Solve complete mathematical problems using appropriate technology.
Mean (3.81); Median (4.00); SD (.40); IQR (0); and CS (61)

4. Represent mathematics in multiple ways.
Mean (3.63); Median (4.00); SD (.62); IQR (1.00); and CS (58)

5. Reason and evaluate mathematical arguments.
Mean (3.60); Median (4.00); SD (.63); IQR (1.00); and CS (54)

Mathematics Abilities

1. Make connections among mathematical ideas and to other disciplines.
Mean (3.69); Median (4.00); SD (.60); IQR (.75); and CS (59)

2. Ability to calculate the food cost of a meal and set a food budget for planning.
Mean (3.94); Median (4.00); SD (.25); IQR (0); and CS (63)

3. Calculate unit cost, and understand what a unit is.
Mean (3.94); Median (4.00); SD (.25); IQR (0); and CS (63)

4. Perform a variety of experiences on food science and nutrition research and present findings.
Mean (3.93); Median (4.00); SD (.26); IQR (0); and CS (59)

Mathematics Knowledge

1. Understand ratios, calibration, and estimation in relation to the cooking process.
Mean (3.69); Median (4.00); SD (.48); IQR (1.00); and CS (59)

2. Understand mathematical concepts to adjust a recipe and work formulas.
Mean (3.88); Median (4.00); SD (.34); IQR (0); and CS (62)

3. Know conversions and equivalents using metric to US standard measurements.
Mean (3.81); Median (4.00); SD (.40); IQR (0); and CS (61)

Table 8

Round 2 Descriptive Statistics including the statement, mean, median, standard deviation, IQR, and composite score

Strategies and Recommendations
1. Provide secondary students with opportunities to participate in STEM jobs during the school year and summer. Mean (3.50); Median (3.50); SD (.52); IQR (1.00); and CS (56)
2. Provide opportunities for STEM conferences for family and consumer sciences education professionals. Mean (3.75); Median (4.00); SD (.45); IQR (.75); and CS (60)
3. Provide opportunities for STEM workshops for family and consumer sciences students. Mean (3.81); Median (4.00); SD (.40); IQR (0); and CS (61)
4. Teaching-learning collaboration between teachers of STEM subjects and FCS teachers. Mean (3.94); Median (4.00); SD (.25); IQR (0); and CS (63)
5. Provide professional development for teachers to experience the STEM relationships with nutrition and food science career pathways to implement in classrooms. Mean (3.75); Median (4.00); SD (.45); IQR (.75); and CS (60)
6. Develop integrated curriculum for family and consumer sciences with STEM related disciplines. Mean (3.81); Median (4.00); SD (.40); IQR (0); and CS (61)
7. Establish partnership with food and nutrition related industries for student learning. Mean (3.69); Median (4.00); SD (.60); IQR (.75); and CS (59)
8. Update the national FACS standards to include STEM concepts. Mean (3.88); Median (4.00); SD (.34); IQR (0); and CS (62)
9. Create a marketing campaign showing the relationship between STEM education concepts and food science/FCS highlighting integration. Mean (3.75); Median (4.00); SD (.45); IQR (.75); and CS (60)
10. Use of resources, such as “Science and Our Food Supply” program provided by the FDA. Mean (3.81); Median (4.00); SD (.40); IQR (0); and CS (61)
11. Provide job-shadowing and touring opportunities, such as visiting food processing plants or the local supermarkets. Mean (3.69); Median (4.00); SD (.48); IQR (1.00); and CS (59)

12. Develop engaging lessons, such as challenging students to develop a new kitchen gadget.
Mean (3.81); Median (4.00); SD (.40); IQR (0); and CS (61)

13. Use project-based work, develop connections with nutrition/food science businesses and education to assist.
Mean (3.63); Median (4.00); SD (.50); IQR (1.00); and CS (58)

14. Connect with economics education organizations to use math in graphing food supply concepts.
Mean (3.56); Median (4.00); SD (.63); IQR (1.00); and CS (57)

15. Promote e-mentoring with food science educators and businesses to learn more about STEM occupations.
Mean (3.81); Median (4.00); SD (.40); IQR (0); and CS (61)

16. Provide resource materials including lessons and visuals for teachers to use to teach the lessons until they feel comfortable with the content and can create their own.
Mean (3.13); Median (3.00); SD (.89); IQR (2.00); and CS (50)

17. Require FACS teachers to train and earn a science based certificate as part of their pathway teaching requirements.
Mean (3.69); Median (4.00); SD (.48); IQR (1.00); and CS (59)

18. Webinars and conference presentations covering science content for FACS teachers.
Mean (3.69); Median (4.00); SD (.48); IQR (1.00); and CS (59)

19. Update lab design and equipment that accommodate STEM concepts.
Mean (3.69); Median (4.00); SD (.48); IQR (1.00); and CS (59)

20. Incorporate more scientific inquiry and methodology into lab activities.
Mean (3.63); Median (4.00); SD (.50); IQR (1.00); and CS (58)

Tables 9 through 13 represent the composite score and change from Round 2 to Round 3. Although the composite score is not part of the criteria this study established for criteria, it is still valuable to note the change in score as this represents which items had the highest number of Strongly Agree marked according to a Likert-type scale.

Table 9

Composite Score Ranking for Rounds 2 and 3

Statement	Round 2	Round 3	Change
Science Skills			
1. Use standard safety practices for all classroom laboratory and field investigations.	64	60	-4
2. Use tools and instruments for observing, measuring and manipulating scientific equipment and materials.	58	55	-3
3. Identify and investigate problems scientifically.	59	55	-4
4. Demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanation.	57	54	-3
5. Analyze how scientific knowledge is developed.	55	52	-3
6. Collect and organize precise qualitative and quantitative data.	56	51	-5
7. Evaluate the impact of food science on research, society, and the environment.	61	55	-5
8. Distinguish and differentiate between scientific hypothesis and theories.	57	52	-5
9. Communicate scientific investigations and information clearly.	58	54	-4
10. Explain and recognize the value of collaboration and time management.	60	55	-5
11. Work independently or collectively in differing roles.	53	51	-2
12. Evaluate the importance of curiosity, honesty, openness and skepticism in science.	59	55	-4
Science Abilities			
1. Demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanation.	58	53	-5

2. Plan and implement descriptive, comparative, and experimental investigations.	56	50	-6
3. Apply scientific information extracted from various sources such as news, journal articles, and current events.	57	52	-5
4. Present valid conclusions through methods such as lab reports, labeled diagrams, graphic organizers, journals and summaries.	56	55	-1
5. Draw inferences based on data related to scientific investigations.	58	53	-5
Science Knowledge			
1. Understand foodborne illnesses and how they are traced back to the source of contamination.	56	52	-4
2. Explores the role of food additives, leavening agents, and processes of energy production in food.	61	58	-3
3. Understand the effect of pH on pathogens related to food borne illnesses.	60	56	-4
4. Understand important features of the process of scientific inquiry.	63	57	-6
5. Understand the digestive system and how age affects chemical absorption.	56	52	-4

Table 10

Composite Score Ranking for Rounds 2 and 3

Statement	Round 2	Round 3	Change
Technology Skills			
1. Demonstrate employability and leadership skills required by business and industry.	58	53	-5
2. Demonstrate and incorporate safe laboratory procedures in lab, shop, and field environments.	64	60	-4

3. Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities.	63	59	-4
4. Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products.	57	53	-4
5. Exhibit critical thinking and problem solving skills to locate, analyze, and apply information in career planning and employment situations.	59	55	-4
6. Given a group of food products, students should be able to properly design procedures for prepare certain nutritional meals that reflect technology changes through various historical time periods.	51	47	-4
7. Create historical props or prototypes for nutritional displays and presentations.	49	42	-7
8. Present a professional image through appearance, behavior, and language in the workplace and lab settings.	58	54	-4
9. Demonstrate ethical and professional engineering behavior in the development and use of technology.	56	52	-4
10. Work independently, interpret data, and apply teamwork skills.	57	53	-4
Technology Abilities			
1. Use commercial and residential kitchen equipment, tools, and appliances.	59	54	-5
2. Use appropriate technology to collect, record, manipulate, analyze, and report data.	63	58	-5
3. Understand work area organization procedures and follow Standard Operating Procedures (SOP) when performing work.	61	56	-5
4. Accurately interpret safety signs, symbols, and labels (Hazardous Communications).	64	59	-5
5. Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products.	61	56	-5

6. Create electronic presentations, displays, and portfolios for nutrition with the use of computer software.	60	55	-5
7. Apply the appropriate skill sets to be productive in a changing, technological, and diverse workplace to be able to work independently, interpret data, and apply teamwork skills.	61	56	-5
Technology Knowledge			
1. Identify and describe the history of technology and its impact on society in the past, present, and future.	53	47	-6
2. Identify key people who have influenced technological change.	52	47	-5
3. Describe how technological advances impact nutrition, food processing and food safety.	59	54	-5
4. Trace the development food and nutrition as a result of engineering and technology advancements.	54	49	-5
5. Understand how mechanization has increased food supply.	59	54	-5
6. Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products.	58	52	-6
7. Attempt to predict the outcomes based on data collected in a project or experiment.	60	55	-5
8. Draw a conclusion when confronted with data or observations that focus on the observed plans, processes, or projects at hand.	60	56	-4
9. Evaluate the impact of science and society based on products and processes used in the real world for technological development.	56	51	-5

Table 11

Composite Score Ranking for Rounds 2 and 3

Statement	Round 2	Round 3	Change
Engineering Skills			
1. Demonstrate and follow safety, health, and environmental standards related to the engineering workplace.	58	53	-5
2. Model employability skills and work readiness traits required for success in the engineering workplace including integrity, honesty, accountability, punctuality, time management, and respect for diversity.	58	55	-3
3. Design a solution to an engineering problem applying STEM principles.	49	44	-5
4. Create a display and prepare personal portfolio that represent characteristics of one's employability skills.	58	54	-4
5. Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities.	61	57	-4
6. Work independently, interpret data, and apply teamwork skills.	59	56	-3
Engineering Abilities			
1. Apply fundamental principles of the engineering design process.	49	42	-7
2. Describe the principal fields of engineering specializations (ex. aeronautical, automotive, chemical, civil, industrial, mechanical, computer software, electrical, and biomedical) and identify associated career tracks.	47	40	-7
3. Identify the history of engineering and its impact on society in the past, present, and future.	45	40	-5
4. Draw a conclusion when confronted with data or observations that focus on the observed plans, processes, or projects at hand.	57	51	-6

5. Finalize solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, qualitative, virtual, and physical means.	56	49	-7
6. Participate in activities related to engineering career interests.	46	41	-5
7. Understand engineering knowledge and skills to analyze and suggest solutions to human societal problems.	51	47	-4
8. Understand and apply the engineering design process through project based learning activities.	51	47	-4
Engineering Knowledge			
1. Exhibit critical thinking and problem solving skills to locate, analyze, and apply information in career planning and employment situations.	58	54	-4
2. Explain how the incorporation or lack of safety practices impact the economy and costs of safety in business and industry.	59	55	-4
3. Explain how the creativity and systematic design approaches impact food and nutrition; consequently affect health of society's workforce.	58	53	-5
4. Identify personal characteristics that employers are interested in prospective workers.	56	52	-4
5. Understanding of Industrialized food systems and its impact on the nutritional health of the population.	57	53	-4
6. Research and prepare presentation of engineering careers that have direct impacts on development of food and nutrition disciplines.	54	47	-7
7. Conduct technical research to develop possible solutions to a stated engineering problem.	52	49	-3

Table 12

Composite Score Ranking for Rounds 2 and 3

Statement	Round 2	Round 3	Change
Mathematics Skills			
1. Communicate mathematically verbally, written, and electronically.	63	57	-6
2. Solve mathematical problems based on field investigations and laboratory experiments	61	57	-4
3. Solve complete mathematical problems using appropriate technology	61	56	-5
4. Represent mathematics in multiple ways.	58	51	-7
5. Reason and evaluate mathematical arguments	54	53	-1
Mathematics Abilities			
1. Make connections among mathematical ideas and to other disciplines.	59	57	-2
2. Ability to calculate the food cost of a meal and set a food budget for planning.	63	59	-4
3. Calculate unit cost, and understand what a unit is.	63	59	-4
4. Perform a variety of experiences on food science and nutrition research and present findings.	59	58	-1
Mathematics Knowledge			
1. Understand ratios, calibration, and estimation in relation to the cooking process	59	54	-5
2. Understand mathematical concepts to adjust a recipe and work formulas.	62	58	-4
3. Know conversions and equivalents using metric to US standard measurements.	61	56	-5

Table 13

Composite Score Ranking for Rounds 2 and 3

Statement	Round 2	Round 3	Change
Strategies and Recommendations			
1. Provide secondary students with opportunities to participate in STEM jobs during the school year and summer.	56	52	-4
2. Provide opportunities for STEM conferences for family and consumer sciences education professionals.	60	56	-4
3. Provide opportunities for STEM workshops for family and consumer sciences students.	61	57	-4
4. Teaching-learning collaboration between teachers of STEM subjects and FCS teachers.	63	59	-4
5. Provide professional development for teachers to experience the STEM relationships with nutrition and food science career pathways to implement in classrooms.	60	55	-5
6. Develop integrated curriculum for family and consumer sciences with STEM related disciplines.	61	56	-5
7. Establish partnership with food and nutrition related industries for student learning.	59	55	-4
8. Update the national FACS standards to include STEM concepts.	62	58	-4
9. Create a marketing campaign showing the relationship between STEM education concepts and food science/FCS highlighting integration.	60	55	-5
10. Use of resources, such as “Science and Our Food Supply” program provide by the FDA.	61	56	-5
11. Provide job-shadowing and touring opportunities, such as visiting food processing plants or the local supermarkets.	59	54	-5

12. Develop engaging lessons, such as challenging students to develop a new kitchen gadget.	61	57	-4
13. Use project-based work, develop connections with nutrition/food science businesses and education to assist.	58	52	-6
14. Connect with economics education organizations to use math in graphing food supply concepts.	57	53	-4
15. Promote e-mentoring with food science educators and businesses to learn more about STEM occupations.	61	56	-5
16. Provide resource materials including lessons and visuals for teachers to use to teach the lessons until they feel comfortable with the content and can create their own.	50	44	-6
17. Require FACS teachers to train and earn a science based certificate as part of their pathway teaching requirements.	59	54	-5
18. Webinars and conference presentations covering science content for FACS teachers.	59	53	-6
19. Update lab design and equipment that accommodate STEM concepts.	59	55	-4
20. Incorporate more scientific inquiry and methodology into lab activities.	58	54	-4

Round 3

The instrument for Round 3 included the Round 2 statements and provided each participant with their individual score, the panel mean, the option to select a new response, and a no change option. Participants received the explanation and Round 3 questionnaire via QualTrics. Participants were invited to a.) review their responses; b.) review the panel mean; c.) revise their opinion if necessary or indicate “no-change.” Fifteen participants completed Round 3 for a participation rate of 75%. Upon receiving the completed surveys, the descriptive statistics were re-calculated for each of the statements.

In order to condense table length in tables 14 through 23, the researcher provided only the statement number, omitting the statement. The entire statement can be referenced in tables 9 through 13. Tables 14 through 18 represent the round means and standard deviation difference between Rounds 2 and 3.

Table 14

Round 2 & 3 Mean & Standard Deviation Difference

Statement	Round 2 Mean	Round 2 SD	Round 3 Mean	Round 3 SD	SD Difference
Science Skills					
1	4.00	.00	4.00	.00	0
2	3.63	.50	3.67	.499	.01
3	3.69	.479	3.67	.488	-.009
4	3.56	.512	3.60	.507	.005
5	3.44	.512	3.47	.516	-.004
6	3.50	.632	3.40	.632	0
7	3.81	.403	3.67	.817	-.414
8	3.56	.512	3.47	.516	-.004
9	3.63	.50	3.60	.507	-.007
10	3.75	.447	3.67	.488	-.041
11	3.53	.516	3.40	.507	.0009
12	3.69	.479	3.67	.488	-.009
Science Abilities					
1	3.63	.50	3.53	.516	-.016
2	3.50	.516	3.33	.488	.028

3	3.56	.512	3.47	.516	-.004
4	3.69	.479	3.67	.488	-.009
5	3.63	.50	3.53	.834	-.334
Science Knowledge					
1	3.50	.516	3.47	.516	0
2	3.81	.403	3.87	.352	.051
3	3.75	.447	3.73	.458	-.011
4	3.94	.25	3.80	.775	-.525
5	3.50	.52	3.47	.516	.004

Table 15

Round 2 & 3 Mean & Standard Deviation Difference

Statement	Round 2 Mean	Round 2 SD	Round 3 Mean	Round 3 SD	SD Difference
Technology Skills					
1	3.63	.50	3.53	.516	-.016
2	4.00	.00	4.00	.00	0
3	3.94	.25	3.93	.258	-.008
4	3.56	.51	3.53	.516	-.006
5	3.69	.48	3.67	.488	-.008
6	3.19	.83	3.13	.834	-.004
7	3.06	.77	2.80	.775	-.005
8	3.63	.50	3.60	.507	-.007
9	3.50	.63	3.45	.516	.114
10	3.56	.51	3.53	.516	-.006
Technology Abilities					
1	3.69	.48	3.64	.497	-.017

2	3.94	.25	3.86	.363	-.113
3	3.81	.40	3.79	.426	-.026
4	4.00	.00	3.93	.267	-.267
5	3.81	.40	3.79	.426	-.026
6	3.75	.45	3.71	.469	-.019
7	3.81	.40	3.79	.426	-.026
Technology Knowledge					
1	3.31	.48	3.14	.663	-.183
2	3.25	.58	3.14	.663	-.083
3	3.69	.48	3.64	.497	-.017
4	3.60	.51	3.50	.519	-.009
5	3.69	.48	3.64	.497	-.017
6	3.63	.50	3.50	.519	-.019
7	3.75	.45	3.71	.469	-.019
8	3.75	.45	3.79	.426	.024
9	3.5	.52	3.43	.514	.006

Table 16

Round 2 & 3 Mean & Standard Deviation Difference

Statement	Round 2 Mean	Round 2 SD	Round 3 Mean	Round 3 SD	SD Difference
Engineering Skills					
1	3.63	.62	3.53	.640	-.02
2	3.63	.62	3.67	.488	.132
3	3.06	.85	2.93	.799	.051
4	3.63	.50	3.60	.507	-.007
5	3.81	.40	3.80	.414	-.014

6	3.69	.48	3.73	.458	.022
Engineering Abilities					
1	3.06	.93	2.80	.862	.068
2	2.94	1.00	2.67	.817	.183
3	2.81	1.05	2.67	.817	.233
4	3.56	.51	3.40	.507	.003
5	3.50	.63	3.27	.564	.066
6	2.88	.81	2.73	.704	.106
7	3.19	.83	3.13	.834	-.004
8	3.19	.83	3.13	.834	-.004
Engineering Knowledge					
1	3.62	.50	3.60	.507	-.007
2	3.69	.48	3.67	.488	-.008
3	3.62	.50	3.53	.516	-.016
4	3.50	.63	3.47	.516	.114
5	3.56	.51	3.53	.516	-.006
6	3.38	.62	.62	.617	.003
7	3.25	.77	.77	.704	.066

Table 17

Round 2 & 3 Mean & Standard Deviation Difference

Statement	Round 2 Mean	Round 2 SD	Round 3 Mean	Round 3 SD	SD Difference
Mathematics Skills					
1	3.94	.25	3.80	.414	-.164
2	3.81	.40	3.80	.414	-.014

3	3.81	.40	3.73	.458	-.058
4	3.63	.62	3.67	.488	.132
5	3.60	.63	3.53	.516	.114
Mathematics Abilities					
1	3.69	.60	3.80	.414	.186
2	3.94	.25	3.93	.258	-.008
3	3.94	.25	3.93	.258	-.008
4	3.93	.26	3.87	.352	-.092
Mathematics Knowledge					
1	3.69	.48	3.60	.507	-.027
2	3.88	.34	3.87	.352	-.012
3	3.81	.40	3.73	.458	-.058

Table 18

Round 2 & 3 Mean & Standard Deviation Difference

Statement	Round 2 Mean	Round 2 SD	Round 3 Mean	Round 3 SD	SD Difference
Strategies and Recommendations					
1	3.50	.52	3.47	.516	.004
2	3.75	.45	3.73	.458	-.008
3	3.81	.40	3.80	.414	-.014
4	3.94	.25	3.93	.258	-.008
5	3.75	.45	3.67	.488	-.038
6	3.81	.40	3.73	.458	-.058
7	3.69	.60	3.67	.617	-.017
8	3.88	.34	3.87	.352	-.012

9	3.75	.45	3.67	.488	-.038
10	3.81	.40	3.73	.458	-.058
11	3.69	.48	3.60	.507	-.027
12	3.81	.40	3.80	.414	-.014
13	3.63	.50	3.47	.640	-.14
14	3.56	.63	3.53	.640	-.01
15	3.81	.40	3.73	.457	-.057
16	3.13	.89	2.93	.80	.09
17	3.69	.48	3.60	.507	-.027
18	3.69	.48	3.53	.516	-.036
19	3.69	.48	3.67	.488	-.008
20	3.63	.50	3.60	.507	-.007

Tables 19 through 23 represent the frequency and responses for each item according to the Likert-type scale for Rounds 2 and 3. The established percent for this study for any statement to reach consensus is set at 62.5%. Of the 22 Science Statements, 13 in Round 2 and 11 in Round 3 reached a 62.5% or higher mark for strongly agree. Of the 26 Technology Statements, 17 in Round 2 and 11 in Round 3 reached a 62.5% or higher mark for strongly agree. Of the 21 Engineering Statements, 8 in Round 2 and 4 in Round 3 reached a 62.5% or higher mark for strongly agree. Of the 12 Mathematics Statements, all 12 in Round 2 and 10 in Round 3 reached a 62.5% or higher mark for strongly agree. Of the 20 Strategies and Recommendations Statements, 18 in Round 2 and 12 in Round 3 reached a 62.5% or higher mark for strongly agree. Overall, 48 statements out of 101 reached 62.5% or higher for Round 3.

Table 19

Round 2 and 3 Frequency and Percentage of Responses for Each Item

Science Skills

Statement	Round 2 Frequency %				Round 3 Frequency %			
	SA	A	D	SD	SA	A	D	SD
1	100	0	0	0	100	0	0	0
2	62.5	37.5	0	0	66.67	33.33	0	0
3	68.75	31.25	0	0	66.67	33.33	0	0
4	56.25	43.75	0	0	60	40	0	0
5	43.75	56.25	0	0	46.67	53.33	0	0
6	56.25	37.5	6.25	0	46.67	46.67	6.67	0
7	81.25	18.75	0	0	80	13.33	0	6.67
8	56.25	43.75	0	0	46.67	53.33	0	0
9	62.5	37.5	0	0	60	40	0	0
10	75	25	0	0	66.67	33.33	0	0
11	53.33	46.67	0	0	40	60	0	0
12	68.75	31.25	0	0	66.67	33.33	0	0

Science Abilities

Statement	Round 2 Frequency %				Round 3 Frequency %			
	SA	A	D	SD	SA	A	D	SD
1	62.5	37.5	0	0	53.33	46.67	0	0
2	50	50	0	0	33.33	66.67	0	0
3	56.25	43.75	0	0	46.67	53.33	0	0
4	68.75	31.25	0	0	66.67	33.33	0	0
5	62.5	37.5	0	0	66.67	26.67	6.67	0

Science Knowledge								
Statement	Round 2 Frequency %				Round 3 Frequency %			
	SA	A	D	SD	SA	A	D	SD
1	50	50	0	0	46.67	53.33	0	0
2	81.25	18.75	0	0	86.67	13.33	0	0
3	75	25	0	0	73.33	26.67	0	0
4	93.75	6.25	0	0	93.33	0	0	6.67
5	50	50	0	0	46.67	53.33	0	0

Table 20

Round 2 and 3 Frequency and Percentage of Responses for Each Item

Technology Skills								
Statement	Round 2 Frequency %				Round 3 Frequency %			
	SA	A	D	SD	SA	A	D	SD
1	62.5	37.5	0	0	53.33	46.67	0	0
2	100	0	0	0	100	0	0	0
3	93.75	6.25	0	0	93.33	6.67	0	0
4	56.25	43.75	0	0	53.33	46.67	0	0
5	68.75	31.25	0	0	66.67	33.33	0	0
6	43.75	31.25	25	0	40	33.33	26.67	0
7	31.25	43.75	25	0	20	40	40	0
8	62.5	37.5	0	0	60	40	0	0
9	56.25	37.5	6.25	0	46.67	53.33	0	0
10	56.25	43.75	0	0	53.33	46.67	0	0
Technology Abilities								
Statement	Round 2 Frequency %				Round 3 Frequency %			

	SA	A	D	SD	SA	A	D	SD
1	68.75	31.25	0	0	60	40	0	0
2	93.75	6.25	0	0	86.67	13.33	0	0
3	81.25	18.75	0	0	73.33	26.67	0	0
4	100	0	0	0	93.33	6.67	0	0
5	81.25	18.75	0	0	80	20	0	0
6	75	25	0	0	66.67	33.33	0	0
7	81.25	18.75	0	0	73.33	26.67	0	0

Technology Knowledge								
Statement	Round 2 Frequency %				Round 3 Frequency %			
	SA	A	D	SD	SA	A	D	SD
1	31.25	68.75	0	0	26.67	60	13.33	0
2	31.25	62.5	6.25	0	26.67	60	13.33	0
3	68.75	31.25	0	0	60	40	0	0
4	60	40	0	0	50	50	0	0
5	68.75	31.25	0	0	60	40	0	0
6	62.5	37.5	0	0	46.67	53.33	0	0
7	75	25	0	0	66.67	33.33	0	0
8	75	25	0	0	73.33	26.67	0	0
9	50	50	0	0	40	60	0	0

Table 21

Round 2 and 3 Frequency and Percentage of Responses for Each Item

Engineering Skills								
Statement	Round 2 Frequency %				Round 3 Frequency %			
	SA	A	D	SD	SA	A	D	SD

1	100	0	0	0	60	33.33	6.67	0
2	68.75	25	6/25	0	66.67	33.33	0	0
3	31.25	50	12.5	6.25	20	60	13.33	0
4	62.5	37.5	0	0	60	40	0	0
5	81.25	18.75	0	0	80	20	0	0
6	68.75	31.25	0	0	73.33	26.67	0	0

Engineering Abilities

Statement	Round 2 Frequency %				Round 3 Frequency %			
	SA	A	D	SD	SA	A	D	SD
1	37.5	37.5	18.75	6.25	20	40	26.67	6.67
2	31.25	43.75	12.5	12.5	6.67	66.67	13.33	13.33
3	31.25	31.25	25	12.5	13.33	46.67	33.33	6.67
4	56.25	43.75	0	0	40	60	0	0
5	56.25	37.5	6.25	0	33.33	60	6.67	0
6	18.75	56.25	18.75	6.25	6.67	73.33	20	6.67
7	37.5	50	6.25	6.25	33.33	53.33	6.67	6.67
8	37.5	50	6.25	6.25	33.33	53.33	6.67	6.67

Engineering Knowledge

Statement	Round 2 Frequency %				Round 3 Frequency %			
	SA	A	D	SD	SA	A	D	SD
1	62.5	37.5	0	0	60	40	0	0
2	68.75	31.25	0	0	66.67	33.33	0	0
3	62.5	37.5	0	0	53.33	46.67	0	0
4	56.25	37.5	6.25	0	46.67	53.33	0	0
5	56.25	43.75	0	0	53.33	46.67	0	0
6	43.75	50	6.25	0	40	53.33	6.67	0

7	43.75	31.25	18.75	0	40	46.67	13.33	0

Table 22

Round 2 and 3 Frequency and Percentage of Responses for Each Item

Mathematics Skills								
Statement	Round 2 Frequency %				Round 3 Frequency %			
	SA	A	D	SD	SA	A	D	SD
1	93.75	6.25	0	0	80	20	0	0
2	81.25	18.75	0	0	80	20	0	0
3	81.25	18.75	0	0	73.33	26.67	0	0
4	68.75	25	3.25	0	66.67	33.33	0	0
5	66.67	26.67	6.67	0	53.33	46.67	0	0
Mathematics Abilities								
Statement	Round 2 Frequency %				Round 3 Frequency %			
	SA	A	D	SD	SA	A	D	SD
1	75	18.75	6.25	0	80	20	0	0
2	93.75	6.25	0	0	93.33	6.67	0	0
3	93.75	6.25	0	0	93.33	6.67	0	0
4	93.33	6.67	0	0	86.67	13.33	0	0
Mathematics Knowledge								
Statement	Round 2 Frequency %				Round 3 Frequency %			
	SA	A	D	SD	SA	A	D	SD
1	68.75	31.25	0	0	60	40	0	0
2	87.5	12.5	0	0	86.67	13.33	0	0
3	81.25	18.75	0	0	73.33	26.67	0	0

Table 23

Round 2 and 3 Frequency and Percentage of Responses for Each Item

Strategies and Recommendations

Statement	Round 2 Frequency %				Round 3 Frequency %			
	SA	A	D	SD	SA	A	D	SD
1	50	50	0	0	46.67	53.33	0	0
2	75	25	0	0	73.33	26.67	0	0
3	81.25	18.75	0	0	80	20	0	0
4	93.75	6.25	0	0	93.33	6.67	0	0
5	75	25	0	0	66.67	33.33	0	0
6	81.25	18.75	0	0	73.33	26.67	0	0
7	75	18.75	6.25	0	73.33	20	6.67	0
8	87.5	12.5	0	0	86.67	13.33	0	0
9	75	25	0	0	66.67	33.33	0	0
10	81.25	18.75	0	0	73.33	26.67	0	0
11	68.75	31.25	0	0	60	40	0	0
12	81.25	18.75	0	0	80	20	0	0
13	62.5	37.5	0	0	53.33	40	6.67	0
14	62.5	31.25	6.25	0	60	33.33	6.67	0
15	81.25	18.75	0	0	73.33	26.67	0	0
16	43.75	25	31.25	0	26.67	40	33.33	0
17	68.75	31.25	0	0	60	40	0	0
18	68.75	31.25	0	0	53.33	46.67	0	0
19	68.75	31.25	0	0	66.67	33.33	0	0
20	62.5	37.5	0	0	60	40	0	0

Tables 24 through 28 represent the descriptive statistics showing the standard deviation and interquartile range for Rounds 2 and 3. Statements with an IQR of 0.0 are determined to have very high consensus, an IQR ≤ (less than) 1.0 are determined to have consensus, and an IQR > (greater than) 1.0 little or no consensus (Heather, Dallolio, Hutchings, Kaner, & White, 2004). Of the 22 Science Statements, 4 in Round 2 and 4 in Round 3 scored an IQR or 0.0. Of the 26 Technology Statements, 7 in Round 2 and 4 in Round 3 scored an IQR or 0.0. Of the 21 Engineering Statements, 1 in Round 2 and 2 in Round 3 scored an IQR or 0.0. Of the 12 Mathematics Statements, 8 in Round 2 and 7 in Round 3 scored an IQR or 0.0. Of the 20 Strategies and Recommendations Statements, 7 in Round 2 and 4 in Round 3 scored an IQR or 0.0. Overall, 27 statements out of 101 in Round 2 and 21 in Round 3 scored an IQR or 0.0.

Table 24

Round 2 and 3 Descriptive Statistics (Standard Deviation and IQR)

Science Skills
1. Use standard safety practices for all classroom laboratory and field investigations. Round 2 SD (.00); Round 2 IQR (0); Round 3 SD (.00); and Round 3 IQR (0)
2. Use tools and instruments for observing, measuring and manipulating scientific equipment and materials. Round 2 SD (.50); Round 2 IQR (1.00); Round 3 SD (.499); and Round 3 IQR (1.00)
3. Identify and investigate problems scientifically. Round 2 SD (.479); Round 2 IQR (1.00); Round 3 SD (.488); and Round 3 IQR (1.00)
4. Demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanation. Round 2 SD (.512); Round 2 IQR (1.00); Round 3 SD (.507); and Round 3 IQR (1.00)
5. Analyze how scientific knowledge is developed. Round 2 SD (.512); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)
6. Collect and organize precise qualitative and quantitative data. Round 2 SD (.632); Round 2 IQR (1.00); Round 3 SD (.632); and Round 3 IQR (1.00)
7. Evaluate the impact of food science on research, society, and the environment. Round 2 SD (.403); Round 2 IQR (0); Round 3 SD (.817); and Round 3 IQR (0)

8. Distinguish and differentiate between scientific hypotheses and theories.
Round 2 SD (.512); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)

9. Communicate scientific investigations and information clearly.
Round 2 SD (.50); Round 2 IQR (1.00); Round 3 SD (.507); and Round 3 IQR (1.00)

10. Explain and recognize the value of collaboration and time management.
Round 2 SD (.447); Round 2 IQR (1.00); Round 3 SD (.488); and Round 3 IQR (1.00)

11. Work independently or collectively in differing roles.
Round 2 SD (.516); Round 2 IQR (1.00); Round 3 SD (.507); and Round 3 IQR (1.00)

12. Evaluate the importance of curiosity, honesty, openness and skepticism in science.
Round 2 SD (.479); Round 2 IQR (1.00); Round 3 SD (.488); and Round 3 IQR (1.00)

Science Abilities

1. Demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanation.
Round 2 SD (.50); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)

2. Plan and implement descriptive, comparative, and experimental investigations.
Round 2 SD (.516); Round 2 IQR (1.00); Round 3 SD (.488); and Round 3 IQR (1.00)

3. Apply scientific information extracted from various sources such as news, journal articles, and current events.
Round 2 SD (.512); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)

4. Present valid conclusions through methods such as lab reports, labeled diagrams, graphic organizers, journals and summaries.
Round 2 SD (.479); Round 2 IQR (1.00); Round 3 SD (.488); and Round 3 IQR (1.00)

5. Draw inferences based on data related to scientific investigations.
Round 2 SD (.50); Round 2 IQR (1.00); Round 3 SD (.834); and Round 3 IQR (1.00)

Science Knowledge

1. Understand important features of the process of scientific inquiry.
Round 2 SD (.516); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)

2. Explores the role of food additives, leavening agents, and processes of energy production in food.
Round 2 SD (.403); Round 2 IQR (0); Round 3 SD (.352); and Round 3 IQR (0)

3. Understand the effect of pH on pathogens related to food borne illnesses.
Round 2 SD (.447); Round 2 IQR (.75); Round 3 SD (.458); and Round 3 IQR (1.00)

4. Understand foodborne illnesses and how they are traced back to the source of contamination.
Round 2 SD (.25); Round 2 IQR (.00); Round 3 SD (.775); and Round 3 IQR (0)

5. Understand the digestive system and how age affects chemical absorption.
Round 2 SD (.52); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)

Table 25

Round 2 and 3 Descriptive Statistics (Standard Deviation and IQR)

Technology Skills

1. Demonstrate employability and leadership skills required by business and industry.
Round 2 SD (.50); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)

2. Demonstrate and incorporate safe laboratory procedures in lab, shop, and field environments.
Round 2 SD (.00); Round 2 IQR (0); Round 3 SD (.00); and Round 3 IQR (0)

3. Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities.
Round 2 SD (.25); Round 2 IQR (0); Round 3 SD (.258); and Round 3 IQR (0)

4. Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products.
Round 2 SD (.51); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)

5. Exhibit critical thinking and problem solving skills to locate, analyze, and apply information in career planning and employment situations.
Round 2 SD (.48); Round 2 IQR (1.00); Round 3 SD (.488); and Round 3 IQR (1.00)

6. Given a group of food products, students should be able to properly design procedures for prepare certain nutritional meals that reflect technology changes through various historical time periods.
Round 2 SD (.83); Round 2 IQR (1.75); Round 3 SD (.834); and Round 3 IQR (2.00)

7. Create historical props or prototypes for nutritional displays and presentations.
Round 2 SD (.77); Round 2 IQR (1.75); Round 3 SD (.775); and Round 3 IQR (1.00)

8. Present a professional image through appearance, behavior, and language in the workplace and lab settings.
Round 2 SD (.50); Round 2 IQR (1.00); Round 3 SD (.507); and Round 3 IQR (1.00)

9. Demonstrate ethical and professional engineering behavior in the development and use of technology.
Round 2 SD (.63); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)

10. Work independently, interpret data, and apply teamwork skills.
Round 2 SD (.51); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)

Technology Abilities

1. Use commercial and residential kitchen equipment, tools, and appliances.
Round 2 SD (.48); Round 2 IQR (1.00); Round 3 SD (.497); and Round 3 IQR (1.00)

2. Use appropriate technology to collect, record, manipulate, analyze, and report data.
Round 2 SD (.25); Round 2 IQR (0); Round 3 SD (.363); and Round 3 IQR (0)

3. Understand work area organization procedures and follow Standard Operating Procedures (SOP) when performing work.
Round 2 SD (.40); Round 2 IQR (0); Round 3 SD (.426); and Round 3 IQR (.25)

4. Accurately interpret safety signs, symbols, and labels (Hazardous Communications).
Round 2 SD (.00); Round 2 IQR (0); Round 3 SD (.267); and Round 3 IQR (0)

5. Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products.
Round 2 SD (.40); Round 2 IQR (0); Round 3 SD (.426); and Round 3 IQR (.25)

6. Create electronic presentations, displays, and portfolios for nutrition with the use of computer software.
Round 2 SD (.45); Round 2 IQR (.75); Round 3 SD (.469); and Round 3 IQR (1.00)

7. Apply the appropriate skill sets to be productive in a changing, technological, and diverse workplace to be able to work independently, interpret data, and apply teamwork skills.
Round 2 SD (.40); Round 2 IQR (0); Round 3 SD (.426); and Round 3 IQR (.25)

Technology Knowledge

1. Identify and describe the history of technology and its impact on society in the past, present, and future.
Round 2 SD (.48); Round 2 IQR (1.00); Round 3 SD (.663); and Round 3 IQR (1.00)

2. Identify key people who have influenced technological change.
Round 2 SD (.58); Round 2 IQR (1.00); Round 3 SD (.663); and Round 3 IQR (1.00)

3. Describe how technological advances impact nutrition, food processing and food safety.
Round 2 SD (.48); Round 2 IQR (1.00); Round 3 SD (.497); and Round 3 IQR (1.00)

4. Trace the development food and nutrition as a result of engineering and technology advancements.
Round 2 SD (.51); Round 2 IQR (1.00); Round 3 SD (.519); and Round 3 IQR (1.00)

5. Understand how mechanization has increased food supply.

Round 2 SD (.48); Round 2 IQR (1.00); Round 3 SD (.497); and Round 3 IQR (1.00)

6. Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products.
Round 2 SD (.50); Round 2 IQR (1.00); Round 3 SD (.519); and Round 3 IQR (1.00)

7. Attempt to predict the outcomes based on data collected in a project or experiment.
Round 2 SD (.45); Round 2 IQR (.75); Round 3 SD (.469); and Round 3 IQR (1.00)

8. Draw a conclusion when confronted with data or observations that focus on the observed plans, processes, or projects at hand.
Round 2 SD (.45); Round 2 IQR (.75); Round 3 SD (.426); and Round 3 IQR (.25)

9. Evaluate the impact of science and society based on products and processes used in the real world for technological development.
Round 2 SD (.52); Round 2 IQR (1.00); Round 3 SD (.514); and Round 3 IQR (1.00)

Table 26

Round 2 and 3 Descriptive Statistics (Standard Deviation and IQR)

Engineering Skills
1. Demonstrate and follow safety, health, and environmental standards related to the engineering workplace. Round 2 SD (.62); Round 2 IQR (1.00); Round 3 SD (.640); and Round 3 IQR (1.00)
2. Model employability skills and work readiness traits required for success in the engineering workplace including integrity, honesty, accountability, punctuality, time management, and respect for diversity. Round 2 SD (.62); Round 2 IQR (1.00); Round 3 SD (.488); and Round 3 IQR (1.00)
3. Design a solution to an engineering problem applying STEM principles. Round 2 SD (.85); Round 2 IQR (1.00); Round 3 SD (.799); and Round 3 IQR (0)
4. Create a display and prepare personal portfolio that represent characteristics of one’s employability skills. Round 2 SD (.50); Round 2 IQR (1.00); Round 3 SD (.507); and Round 3 IQR (1.00)
5. Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities. Round 2 SD (.40); Round 2 IQR (0); Round 3 SD (.414); and Round 3 IQR (0)
6. Work independently, interpret data, and apply teamwork skills. Round 2 SD (.48); Round 2 IQR (1.00); Round 3 SD (.458); and Round 3 IQR (1.00)
Engineering Abilities

1. Apply fundamental principles of the engineering design process.
Round 2 SD (.93); Round 2 IQR (1.75); Round 3 SD (.862); and Round 3 IQR (1.00)

2. Describe the principal fields of engineering specializations (ex. aeronautical, automotive, chemical, civil, industrial, mechanical, computer software, electrical, and biomedical) and identify associated career tracks.
Round 2 SD (1.00); Round 2 IQR (1.75); Round 3 SD (.817); and Round 3 IQR (1.00)

3. Identify the history of engineering and its impact on society in the past, present, and future.
Round 2 SD (1.05); Round 2 IQR (2.00); Round 3 SD (.817); and Round 3 IQR (1.00)

4. Draw a conclusion when confronted with data or observations that focus on the observed plans, processes, or projects at hand.
Round 2 SD (.51); Round 2 IQR (1.00); Round 3 SD (.507); and Round 3 IQR (1.00)

5. Finalize solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, qualitative, virtual, and physical means.
Round 2 SD (.63); Round 2 IQR (1.00); Round 3 SD (.564); and Round 3 IQR (1.00)

6. Participate in activities related to engineering career interests.
Round 2 SD (.81); Round 2 IQR (.75); Round 3 SD (.704); and Round 3 IQR (1.00)

7. Understand engineering knowledge and skills to analyze and suggest solutions to human societal problems.
Round 2 SD (.83); Round 2 IQR (1.00); Round 3 SD (.834); and Round 3 IQR (1.00)

8. Understand and apply the engineering design process through project based learning activities.
Round 2 SD (.83); Round 2 IQR (1.00); Round 3 SD (.834); and Round 3 IQR (1.00)

Engineering Knowledge

1. Exhibit critical thinking and problem solving skills to locate, analyze, and apply information in career planning and employment situations.
Round 2 SD (.50); Round 2 IQR (1.00); Round 3 SD (.507); and Round 3 IQR (1.00)

2. Explain how the incorporation or lack of safety practices impact the economy and costs of safety in business and industry.
Round 2 SD (.48); Round 2 IQR (1.00); Round 3 SD (.488); and Round 3 IQR (1.00)

3. Explain how the creativity and systematic design approaches impact food and nutrition; consequently affect health of society’s workforce.
Round 2 SD (.50); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)

4. Identify personal characteristics that employers are interested in prospective workers.
Round 2 SD (.63); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)

5. Understanding of Industrialized food systems and its impact on the nutritional health of the population.
Round 2 SD (.51); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)

6. Research and prepare presentation of engineering careers that have direct impacts on development of food and nutrition disciplines.
Round 2 SD (.62); Round 2 IQR (1.00); Round 3 SD (.617); and Round 3 IQR (1.00)

7. Conduct technical research to develop possible solutions to a stated engineering problem.
Round 2 SD (.77); Round 2 IQR (1.00); Round 3 SD (.704); and Round 3 IQR (1.00)

Table 27

Round 2 and 3 Descriptive Statistics (Standard Deviation and IQR)

Mathematics Skills
1. Communicate mathematically verbally, written, and electronically. Round 2 SD (.25); Round 2 IQR (0); Round 3 SD (.414); and Round 3 IQR (0)
2. Solve mathematical problems based on field investigations and laboratory experiments Round 2 SD (.40); Round 2 IQR (0); Round 3 SD (.414); and Round 3 IQR (0)
3. Solve complete mathematical problems using appropriate technology. Round 2 SD (.40); Round 2 IQR (0); Round 3 SD (.458); and Round 3 IQR (1.00)
4. Represent mathematics in multiple ways. Round 2 SD (.62); Round 2 IQR (1.00); Round 3 SD (.488); and Round 3 IQR (1.00)
5. Reason and evaluate mathematical arguments. Round 2 SD (.63); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)
Mathematics Abilities
1. Make connections among mathematical ideas and to other disciplines. Round 2 SD (.60); Round 2 IQR (.75); Round 3 SD (.414); and Round 3 IQR (0)
2. Ability to calculate the food cost of a meal and set a food budget for planning. Round 2 SD (.25); Round 2 IQR (0); Round 3 SD (.258); and Round 3 IQR (0)
3. Calculate unit cost, and understand what a unit is. Round 2 SD (.25); Round 2 IQR (0); Round 3 SD (.258); and Round 3 IQR (0)
4. Perform a variety of experiences on food science and nutrition research and present findings. Round 2 SD (.26); Round 2 IQR (0); Round 3 SD (.352); and Round 3 IQR (0)

Mathematics Knowledge
1. Understand ratios, calibration, and estimation in relation to the cooking process. Round 2 SD (.48); Round 2 IQR (1.00); Round 3 SD (.507); and Round 3 IQR (1.00)
2. Understand mathematical concepts to adjust a recipe and work formulas. Round 2 SD (.34); Round 2 IQR (0); Round 3 SD (.352); and Round 3 IQR (0)
3. Know conversions and equivalents using metric to US standard measurements. Round 2 SD (.40); Round 2 IQR (0); Round 3 SD (.458); and Round 3 IQR (1.00)

Table 28

Round 2 and 3 Descriptive Statistics (Standard Deviation and IQR)

Strategies and Recommendations
1. Provide secondary students with opportunities to participate in STEM jobs during the school year and summer. Round 2 SD (.52); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)
2. Provide opportunities for STEM conferences for family and consumer sciences education professionals. Round 2 SD (.45); Round 2 IQR (.75); Round 3 SD (.458); and Round 3 IQR (1.00)
3. Provide opportunities for STEM workshops for family and consumer sciences students. Round 2 SD (.40); Round 2 IQR (0); Round 3 SD (.414); and Round 3 IQR (0)
4. Teaching-learning collaboration between teachers of STEM subjects and FCS teachers. Round 2 SD (.25); Round 2 IQR (0); Round 3 SD (258.); and Round 3 IQR (0)
5. Provide professional development for teachers to experience the STEM relationships with nutrition and food science career pathways to implement in classrooms. Round 2 SD (.45); Round 2 IQR (.75); Round 3 SD (.488); and Round 3 IQR (1.00)
6. Develop integrated curriculum for family and consumer sciences with STEM related disciplines. Round 2 SD (.40); Round 2 IQR (0); Round 3 SD (.458); and Round 3 IQR (1.00)
7. Establish partnership with food and nutrition related industries for student learning. Round 2 SD (.60); Round 2 IQR (.75); Round 3 SD (.617); and Round 3 IQR (1.00)
8. Update the national FACS standards to include STEM concepts. Round 2 SD (.34); Round 2 IQR (0); Round 3 SD (.352); and Round 3 IQR (0)
9. Create a marketing campaign showing the relationship between STEM education concepts and food science/FCS highlighting integration.

Round 2 SD (.45); Round 2 IQR (.75); Round 3 SD (.488); and Round 3 IQR (1.00)

10. Use of resources, such as "Science and Our Food Supply" program provided by the FDA.
Round 2 SD (.40); Round 2 IQR (0); Round 3 SD (.458); and Round 3 IQR (1.00)

11. Provide job-shadowing and touring opportunities, such as visiting food processing plants or the local supermarkets.
Round 2 SD (.48); Round 2 IQR (1.00); Round 3 SD (.507); and Round 3 IQR (1.00)

12. Develop engaging lessons, such as challenging students to develop a new kitchen gadget.
Round 2 SD (.40); Round 2 IQR (0); Round 3 SD (.414); and Round 3 IQR (0)

13. Use project-based work, develop connections with nutrition/food science businesses and education to assist.
Round 2 SD (.50); Round 2 IQR (1.00); Round 3 SD (.640); and Round 3 IQR (1.00)

14. Connect with economics education organizations to use math in graphing food supply concepts.
Round 2 SD (.63); Round 2 IQR (1.00); Round 3 SD (.640); and Round 3 IQR (1.00)

15. Promote e-mentoring with food science educators and businesses to learn more about STEM occupations.
Round 2 SD (.40); Round 2 IQR (0); Round 3 SD (.457); and Round 3 IQR (1.00)

16. Provide resource materials including lessons and visuals for teachers to use to teach the lessons until they feel comfortable with the content and can create their own.
Round 2 SD (.89); Round 2 IQR (2.00); Round 3 SD (.80); and Round 3 IQR (2.00)

17. Require FACS teachers to train and earn a science based certificate as part of their pathway teaching requirements.
Round 2 SD (.48); Round 2 IQR (1.00); Round 3 SD (.507); and Round 3 IQR (1.00)

18. Webinars and conference presentations covering science content for FACS teachers.
Round 2 SD (.48); Round 2 IQR (1.00); Round 3 SD (.516); and Round 3 IQR (1.00)

19. Update lab design and equipment that accommodate STEM concepts.
Round 2 SD (.48); Round 2 IQR (1.00); Round 3 SD (.488); and Round 3 IQR (1.00)

20. Incorporate more scientific inquiry and methodology into lab activities.
Round 2 SD (.50); Round 2 IQR (1.00); Round 3 SD (.507); and Round 3 IQR (1.00)

Tables 29 through 33 represent the Round 3 descriptive statistics including the mean, median, standard deviation, interquartile range and composite score. Of the 22 Science Statements, all 22 had a median of 3 or higher and had an IQR score equal or less than 1. Of the

26 Technology statements, all 26 had a median of 3 or higher and 25 had an IQR score equal or less than 1. Of the 21 Engineering statements, all 21 had a median of 3 or higher and had an IQR score equal or less than 1. Of the 12 Mathematics statements, all 12 had a median of 3 or higher and had an IQR score equal or less than 1. Of the 20 Strategies and Recommendations statements, 20 had a median of 3 or higher and 19 had an IQR score equal or less than 1. The grand total of statements was 101.

Of the 22 Science statements that met the median and interquartile parameters established for this study, all 22 had a 62.5% agreement level or higher, indicating consensus was met. Of the 25 Technology statements that met the median and interquartile parameters established for this study, 24 had a 62.5% agreement level or higher, indicating consensus was met. Of the 21 Engineering statements that met the median and interquartile parameters established for this study, 19 had a 62.5% agreement level or higher, indicating consensus was met. Of the 12 Mathematics statements that met the median and interquartile parameters established for this study, all 12 had a 62.5% agreement level or higher, indicating consensus was met. Of the 19 Strategy and Recommendations statements that met the median and interquartile parameters established for this study, all 19 had a 62.5% agreement level or higher, indicating consensus was met.

Table 29

Round 3 Descriptive Statistics including the statement, mean, median, standard deviation, IQR, and composite score

Science Skills
1. Use standard safety practices for all classroom laboratory and field investigations Mean (4.00); Median (4.00); SD (.00); IQR (0); and CS (60)
2. Use tools and instruments for observing, measuring and manipulating scientific equipment and materials. Mean (3.67); Median (4.00); SD (.499); IQR (1.00); and CS (55)

3. Identify and investigate problems scientifically.
Mean (3.67); Median (4.00); SD (.488); IQR (1.00); and CS (55)

4. Demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanation.
Mean (3.60); Median (4.00); SD (.507); IQR (1.00); and CS (54)

5. Analyze how scientific knowledge is developed.
Mean (3.47); Median (3.00); SD (.516); IQR (1.00); and CS (52)

6. Collect and organize precise qualitative and quantitative data.
Mean (3.40); Median (3.00); SD (.632); IQR (1.00); and CS (51)

7. Evaluate the impact of food science on research, society, and the environment.
Mean (3.67); Median (4.00); SD (.817); IQR (0); and CS (55)

8. Distinguish and differentiate between scientific hypotheses and theories.
Mean (3.47); Median (3.00); SD (.516); IQR (1.00); and CS (52)

9. Communicate scientific investigations and information clearly.
Mean (3.60); Median (4.00); SD (.507); IQR (1.00); and CS (54)

10. Explain and recognize the value of collaboration and time management.
Mean (3.67); Median (4.00); SD (.488); IQR (1.00); and CS (55)

11. Work independently or collectively in differing roles.
Mean (3.40); Median (3.00); SD (.507); IQR (1.00); and CS (51)

12. Evaluate the importance of curiosity, honesty, openness and skepticism in science.
Mean (3.67); Median (4.00); SD (.488); IQR (1.00); and CS (55)

Science Abilities

1. Demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanation.
Mean (3.53); Median (4.00); SD (.516); IQR (1.00); and CS (53)

2. Plan and implement descriptive, comparative, and experimental investigations.
Mean (3.33); Median (3.00); SD (.488); IQR (1.00); and CS (50)

3. Apply scientific information extracted from various sources such as news, journal articles, and current events.
Mean (3.47); Median (3.00); SD (.516); IQR (1.00); and CS (52)

4. Present valid conclusions through methods such as lab reports, labeled diagrams, graphic organizers, journals and summaries.
Mean (3.67); Median (4.00); SD (.488); IQR (1.00); and CS (55)

5. Draw inferences based on data related to scientific investigations.
Mean (3.53); Median (4.00); SD (.834); IQR (1.00); and CS (53)

Science Knowledge
1. Understand important features of the process of scientific inquiry. Mean (3.47); Median (3.00); SD (.516); IQR (1.00); and CS (52)
2. Explores the role of food additives, leavening agents, and processes of energy production in food. Mean (3.87); Median (4.00); SD (.352); IQR (0); and CS (58)
3. Understand the effect of pH on pathogens related to food borne illnesses. Mean (3.73); Median (4.00); SD (.458); IQR (1.00); and CS (56)
4. Understand foodborne illnesses and how they are traced back to the source of contamination. Mean (3.80); Median (4.00); SD (.775); IQR (0); and CS (57)
5. Understand the digestive system and how age affects chemical absorption. Mean (3.47); Median (3.00); SD (.516); IQR (1.00); and CS (52)

Table 30

Round 3 Descriptive Statistics including the statement, mean, median, standard deviation, IQR, and composite score

Technology Skills
1. Demonstrate employability and leadership skills required by business and industry. Mean (3.53); Median (4.00); SD (.516); IQR (1.00); and CS (53)
2. Demonstrate and incorporate safe laboratory procedures in lab, shop, and field environments. Mean (4.00); Median (4.00); SD (.00); IQR (0); and CS (60)
3. Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities. Mean (3.93); Median (4.00); SD (.258); IQR (0); and CS (59)
4. Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products. Mean (3.53); Median (4.00); SD (.516); IQR (1.00); and CS (53)
5. Exhibit critical thinking and problem solving skills to locate, analyze, and apply information in career planning and employment situations. Mean (3.67); Median (4.00); SD (.488); IQR (1.00); and CS (55)
6. Given a group of food products, students should be able to properly design procedures for prepare certain nutritional meals that reflect technology changes through various historical time periods.

Mean (3.13); Median (3.00); SD (.834); IQR (2.00); and CS (47)

7. Create historical props or prototypes for nutritional displays and presentations.
Mean (2.80); Median (3.00); SD (.775); IQR (1.00); and CS (42)

8. Present a professional image through appearance, behavior, and language in the workplace and lab settings.
Mean (3.60); Median (4.00); SD (.507); IQR (1.00); and CS (54)

9. Demonstrate ethical and professional engineering behavior in the development and use of technology.
Mean (3.45); Median (3.00); SD (.516); IQR (1.00); and CS (52)

10. Work independently, interpret data, and apply teamwork skills.
Mean (3.53); Median (4.00); SD (.516); IQR (1.00); and CS (53)

Technology Abilities

1. Use commercial and residential kitchen equipment, tools, and appliances.
Mean (3.64); Median (4.00); SD (.497); IQR (1.00); and CS (54)

2. Use appropriate technology to collect, record, manipulate, analyze, and report data.
Mean (3.86); Median (4.00); SD (.363); IQR (0); and CS (58)

3. Understand work area organization procedures and follow Standard Operating Procedures (SOP) when performing work.
Mean (3.79); Median (4.00); SD (.426); IQR (.25); and CS (56)

4. Accurately interpret safety signs, symbols, and labels (Hazardous Communications).
Mean (3.93); Median (4.00); SD (.267); IQR (0); and CS (59)

5. Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products.
Mean (3.79); Median (4.00); SD (.426); IQR (.25); and CS (56)

6. Create electronic presentations, displays, and portfolios for nutrition with the use of computer software.
Mean (3.71); Median (4.00); SD (.469); IQR 1.00(); and CS (55)

7. Apply the appropriate skill sets to be productive in a changing, technological, and diverse workplace to be able to work independently, interpret data, and apply teamwork skills.
Mean (3.79); Median (4.00); SD (.426); IQR (.25); and CS (56)

Technology Knowledge

1. Identify and describe the history of technology and its impact on society in the past, present, and future.
Mean (3.14); Median (3.00); SD (.663); IQR (1.00); and CS (47)

2. Identify key people who have influenced technological change.

Mean (3.14); Median (3.00); SD (.663); IQR (1.00); and CS (47)

3. Describe how technological advances impact nutrition, food processing and food safety.
Mean (3.64); Median (4.00); SD (.497); IQR (1.00); and CS (54)

4. Trace the development food and nutrition as a result of engineering and technology advancements.
Mean (3.50); Median (3.50); SD (.519); IQR (1.00); and CS (49)

5. Understand how mechanization has increased food supply.
Mean (3.64); Median (4.00); SD (.497); IQR (1.00); and CS (54)

6. Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products.
Mean (3.50); Median (3.50); SD (.519); IQR (1.00); and CS (52)

7. Attempt to predict the outcomes based on data collected in a project or experiment.
Mean (3.71); Median (4.00); SD (.469); IQR (1.00); and CS (55)

8. Draw a conclusion when confronted with data or observations that focus on the observed plans, processes, or projects at hand.
Mean (3.79); Median (4.00); SD (.426); IQR (.25); and CS (56)

9. Evaluate the impact of science and society based on products and processes used in the real world for technological development.
Mean (3.43); Median (3.00); SD (.514); IQR (1.00); and CS (51)

Table 31

Round 3 Descriptive Statistics including the statement, mean, median, standard deviation, IQR, and composite score

Engineering Skills
1. Demonstrate and follow safety, health, and environmental standards related to the engineering workplace. Mean (3.53); Median (4.00); SD (.640); IQR 1.00(); and CS (53)
2. Model employability skills and work readiness traits required for success in the engineering workplace including integrity, honesty, accountability, punctuality, time management, and respect for diversity. Mean (3.67); Median (4.00); SD (.488); IQR (1.00); and CS (55)
3. Design a solution to an engineering problem applying STEM principles. Mean (2.93); Median (3.00); SD (.799); IQR (0); and CS (44)

4. Create a display and prepare personal portfolio that represent characteristics of one's employability skills.
Mean (3.60); Median (4.00); SD (.507); IQR (1.00); and CS (54)

5. Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities.
Mean (3.80); Median (4.00); SD (.414); IQR (0); and CS (57)

6. Work independently, interpret data, and apply teamwork skills.
Mean (3.73); Median (4.00); SD (.458); IQR (1.00); and CS (56)

Engineering Abilities

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1. Apply fundamental principles of the engineering design process.
Mean (2.80); Median (3.00); SD (.862); IQR (1.00); and CS (42)

2. Describe the principal fields of engineering specializations (ex. aeronautical, automotive, chemical, civil, industrial, mechanical, computer software, electrical, and biomedical) and identify associated career tracks.
Mean (2.67); Median (3.00); SD (.817); IQR (1.00); and CS (40)

3. Identify the history of engineering and its impact on society in the past, present, and future.
Mean (2.67); Median (3.00); SD (.817); IQR (1.00); and CS (40)

4. Draw a conclusion when confronted with data or observations that focus on the observed plans, processes, or projects at hand.
Mean (3.40); Median (3.00); SD (.507); IQR (1.00); and CS (51)

5. Finalize solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, qualitative, virtual, and physical means.
Mean (3.27); Median (3.00); SD (.564); IQR (1.00); and CS (49)

6. Participate in activities related to engineering career interests.
Mean (2.73); Median (3.00); SD (.704); IQR (1.00); and CS (41)

7. Understand engineering knowledge and skills to analyze and suggest solutions to human societal problems.
Mean (3.13); Median (3.00); SD (.834); IQR (1.00); and CS (47)

8. Understand and apply the engineering design process through project based learning activities.
Mean (3.13); Median (3.00); SD (.834); IQR (1.00); and CS (47)

Engineering Knowledge

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1. Exhibit critical thinking and problem solving skills to locate, analyze, and apply information in career planning and employment situations.
Mean (3.60); Median (4.00); SD (.507); IQR (1.00); and CS (54)

2. Explain how the incorporation or lack of safety practices impact the economy and costs of safety in business and industry.
Mean (3.67); Median (4.00); SD (.488); IQR (1.00); and CS (55)

3. Explain how the creativity and systematic design approaches impact food and nutrition; consequently affect health of society's workforce.
Mean (3.53); Median (4.00); SD (.516); IQR (1.00); and CS (53)

4. Identify personal characteristics that employers are interested in prospective workers.
Mean (3.47); Median (3.00); SD (.516); IQR (1.00); and CS (52)

5. Understanding of Industrialized food systems and its impact on the nutritional health of the population.
Mean (3.53); Median (4.00); SD (.516); IQR (1.00); and CS (53)

6. Research and prepare presentation of engineering careers that have direct impacts on development of food and nutrition disciplines.
Mean (3.33); Median (3.00); SD (.617); IQR (1.00); and CS (47)

7. Conduct technical research to develop possible solutions to a stated engineering problem.
Mean (3.27); Median (3.00); SD (.704); IQR (1.00); and CS (49)

Table 32

Round 3 Descriptive Statistics including the statement, mean, median, standard deviation, IQR, and composite score

Mathematics Skills
1. Communicate mathematically verbally, written, and electronically. Mean (3.80); Median (4.00); SD (.414); IQR (0); and CS (57)
2. Solve mathematical problems based on field investigations and laboratory experiments. Mean (3.80); Median (4.00); SD (.414); IQR (0); and CS (57)
3. Solve complete mathematical problems using appropriate technology. Mean (3.73); Median (4.00); SD (.458); IQR (1.00); and CS (56)
4. Represent mathematics in multiple ways. Mean (3.67); Median (4.00); SD (.488); IQR (1.00); and CS (51)
5. Reason and evaluate mathematical arguments. Mean (3.53); Median (4.00); SD (.516); IQR (1.00); and CS (53)
Mathematics Abilities
1. Make connections among mathematical ideas and to other disciplines. Mean (3.80); Median (4.00); SD (.414); IQR (0); and CS (57)

2. Ability to calculate the food cost of a meal and set a food budget for planning.
Mean (3.93); Median (4.00); SD (.258); IQR (0); and CS (59)

3. Calculate unit cost, and understand what a unit is.
Mean (3.93); Median (4.00); SD (.258); IQR (0); and CS (59)

4. Perform a variety of experiences on food science and nutrition research and present findings.
Mean (3.87); Median (4.00); SD (.352); IQR (0); and CS (58)

Mathematics Knowledge

1. Understand ratios, calibration, and estimation in relation to the cooking process.
Mean (3.60); Median (4.00); SD (.507); IQR (1.00); and CS (54)

2. Understand mathematical concepts to adjust a recipe and work formulas.
Mean (3.87); Median (4.00); SD (.352); IQR (0); and CS (58)

3. Know conversions and equivalents using metric to US standard measurements.
Mean (3.73); Median (4.00); SD (.458); IQR (1.00); and CS (56)

Table 33

Round 3 Descriptive Statistics including the statement, mean, median, standard deviation, IQR, and composite score

Strategies and Recommendations

1. Provide secondary students with opportunities to participate in STEM jobs during the school year and summer.
Mean (3.47); Median (3.00); SD (.516); IQR (1.00); and CS (53)

2. Provide opportunities for STEM conferences for family and consumer sciences education professionals.
Mean (3.73); Median (4.00); SD (.458); IQR (1.00); and CS (56)

3. Provide opportunities for STEM workshops for family and consumer sciences students.
Mean (3.80); Median (4.00); SD (.414); IQR (0); and CS (57)

4. Teaching-learning collaboration between teachers of STEM subjects and FCS teachers.
Mean (3.93); Median (4.00); SD (.258); IQR (0); and CS (59)

5. Provide professional development for teachers to experience the STEM relationships with nutrition and food science career pathways to implement in classrooms.
Mean (3.67); Median (4.00); SD (.488); IQR (1.00); and CS (55)

6. Develop integrated curriculum for family and consumer sciences with STEM related disciplines.
Mean (3.73); Median (4.00); SD (.458); IQR (1.00); and CS (56)

7. Establish partnership with food and nutrition related industries for student learning.
Mean (3.67); Median (4.00); SD (.617); IQR (1.00); and CS (55)

8. Update the national FACS standards to include STEM concepts.
Mean (3.87); Median (4.00); SD (.352); IQR (0); and CS (58)

9. Create a marketing campaign showing the relationship between STEM education concepts and food science/FCS highlighting integration.
Mean (3.67); Median (4.00); SD (.488); IQR (1.00); and CS (55)

10. Use of resources, such as “Science and Our Food Supply” program provided by the FDA.
Mean (3.73); Median (4.00); SD (.458); IQR (1.00); and CS (56)

11. Provide job-shadowing and touring opportunities, such as visiting food processing plants or the local supermarkets.
Mean (3.60); Median (4.00); SD (.507); IQR (1.00); and CS (54)

12. Develop engaging lessons, such as challenging students to develop a new kitchen gadget.
Mean (3.80); Median (4.00); SD (.414); IQR (0); and CS (57)

13. Use project-based work, develop connections with nutrition/food science businesses and education to assist.
Mean (3.47); Median (4.00); SD (.640); IQR (1.00); and CS (52)

14. Connect with economics education organizations to use math in graphing food supply concepts.
Mean (3.53); Median (4.00); SD (.640); IQR (1.00); and CS (53)

15. Promote e-mentoring with food science educators and businesses to learn more about STEM occupations.
Mean (3.73); Median (4.00); SD (.457); IQR (1.00); and CS (56)

16. Provide resource materials including lessons and visuals for teachers to use to teach the lessons until they feel comfortable with the content and can create their own.
Mean (2.93); Median (3.00); SD (.80); IQR (2.00); and CS (44)

17. Require FACS teachers to train and earn a science based certificate as part of their pathway teaching requirements.
Mean (3.60); Median (4.00); SD (.507); IQR (1.00); and CS (54)

18. Webinars and conference presentations covering science content for FACS teachers.
Mean (3.53); Median (4.00); SD (.516); IQR (1.00); and CS (53)

19. Update lab design and equipment that accommodate STEM concepts.
Mean (3.67); Median (4.00); SD (.488); IQR (1.00); and CS (55)

20. Incorporate more scientific inquiry and methodology into lab activities.
Mean (3.60); Median (4.00); SD (.507); IQR (1.00); and CS (54)

CHAPTER 5

Discussion

The purpose of this Delphi study was to project the integration and contribution of science, technology, engineering, and mathematics (STEM) education concepts into the nutrition and food science career pathway curriculum at the secondary level. STEM education concepts were defined as *skills, abilities, and knowledge* associated with the disciplines of science, technology, engineering and/or mathematics needed to pursue a related career (Koul & Evans 2012; Shatkin, 2009). The objectives of this study were accomplished by using an expert panel comprised of professionals in family and consumer science and those in the STEM fields. The Delphi technique was used with three completed rounds.

Summary

The Delphi method without modifications included five open-ended questions and was used to answer the following research questions.

1. With respect to skills, abilities, and knowledge, what STEM Education concepts should be included in the nutrition and food science career pathway curriculum?

2. What should the family and consumer sciences education profession do to integrate STEM Education concepts (skills, abilities, and knowledge associated with the disciplines of science, technology, engineering, and mathematics) into the nutrition and food science career pathway curriculum?

3. What should be some contributions of integrating STEM Education concepts (skills, abilities, and knowledge associated with the disciplines of science, technology, engineering, and

mathematics) into the family and consumer sciences education curriculum generally and the nutrition and food science career pathway specifically?

The panel for this study was selected through nominations from well-known experts in the field. Using experts from the different sectors in this study strengthens the results as it will have direct implications for secondary teachers and the foods and nutrition pathway; a varying group will offer various perspectives (Linstone & Turoff, 1979). The expert panel for this study was selected from two major learned societies, the Association of Career and Technical Education (ACTE) and the American Association of Family and Consumer Sciences (AAFCS). Teacher educators and administrators were used from the Family and Consumer Sciences Division and STEM educators in the Engineering and Technology Division of ACTE (edTED). Foods and nutrition professionals were used from the Nutrition, Health and Management, and Hospitality Management Division of AAFCS. The panel was selected through nominations from members of the aforementioned organizations.

A Delphi survey was completed to collect data for this study. The instrument was developed upon completion of a pilot study. This Delphi study used a questionnaire; the questionnaire was developed by identifying items via responses from the five open-ended questions provided to participants in Round 1. The researcher consolidated the response items from Round 1 to a final list, eliminating duplicates. The items were formatted into a questionnaire for participants to rate in subsequent rounds.

To rate the items for Round 2, a 4-point Likert-type rating scale was used. Likert scales are commonly used to efficiently gain expert thought on a given topic (Hartley & MacLean, 2006). The Likert scale features statements to which participants select their level of agreement or disagreement. An even numbered response set was selected because this forces participants to commit to a clear orientation toward each item; whereas odd numbered scales can lead to neutrality (Brown, 2000) and do not designate consensus. Thus, requiring participants to have a definite opinion will minimize the chance of inaccurate responses. The scale was anchored as follows: Strongly agree = 4, Agree = 3, Disagree = 2, Strongly disagree = 1. Brief descriptors were chosen because Hartley and MacLean (2006) found that Likert scales with self-descriptive statements (e.g., "I have as much energy as ever.") had lower response rates when compared to brief descriptors (e.g., never).

Interpretation of the Findings

Upon the completion of 3 Rounds in this study, the expert panel identified 101 STEM skills, abilities, and knowledge that should be included in family and consumer science nutrition and food science career pathway courses at the secondary level. For this study, consensus is reached when to following criteria are satisfied: 62.5% of the respondents fall within the median of 3 or higher on a 4-point scale and the IQR is equal to or less than 1.

The five open-ended questions were used to help answer the research questions. For research question 1, the panel identified concepts and themes to answer what STEM education concepts should be included in the nutrition and food science career pathway. The findings highlight STEM standards are already encompassed in the curriculum and should continue to be included. Specific examples include mathematical concepts such as calculating unit cost and formulas.

In research question 2, the panel provided statements to support how family and consumer science professionals can integrate STEM education concepts. Two themes emerged for research question 2. First, there is a need for students to have hands on experience, such as field investigations and laboratory experience to integrate the subjects. Second, there is a need to make connections through writing, speaking, listening, and interpersonal abilities.

In research question 3, the panel provided opinion on what the contributions would be of integrating STEM education concepts with family and consumer sciences and the nutritional and food science career pathway. The items with the highest consensus included opportunities for STEM workshops and FCS students, collaboration between teachers of STEM subjects and FCS teachers, and update the national FCS standards to include STEM concepts.

Of the 101 items, 96 reached consensus after Round 3. Many of the items were general STEM standards indicating STEM is already included in the nutrition and food science curriculum. Therefore the outcomes strongly suggest the need to continue integrating and strengthening STEM educational concepts in the family and consumer sciences nutrition and food science career pathway. Of the 101 items, 20 items had the highest level of consensus with a median of 4 and an IQR of 0. Table 34 displays the statements aforementioned. The STEM concepts in Table 34 are identified as (S) for skill, (A) for ability, and (K) for knowledge.

Table 34

Concepts with Highest Level of Consensus

Science Statements
1. Use standard safety practices for all classroom laboratory and field investigations. (S)
2. Evaluate the impact of food science on research, society, and the environment. (S)
3. Explores the role of food additives, leavening agents, and processes of energy production in food. (K)
4. Understand foodborne illnesses and how they are traced back to the source of contamination. (K)
Technology Statements
1. Demonstrate and incorporate safe laboratory procedures in lab, shop, and field environments. (S)

2. Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities. (S)
3. Use appropriate technology to collect, record, manipulate, analyze, and report data. (A)
4. Accurately interpret safety signs, symbols, and labels (Hazardous Communications). (A)
Engineering Statements
1. Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities. (S)
Mathematics Statements
1. Communicate mathematically verbally, written, and electronically. (S)
2. Solve mathematical problems based on field investigations and laboratory experiments. (S)
3. Make connections among mathematical ideas and to other disciplines. (A)
4. Ability to calculate the food cost of a meal and set a food budget for planning. (A)
5. Calculate unit cost, and understand what a unit is. (A)
6. Perform a variety of experiences on food science and nutrition research and present findings. (A)
7. Understand mathematical concepts to adjust a recipe and work formulas. (K)
Strategies and Recommendations Statements
1. Provide opportunities for STEM workshops for family and consumer sciences students.
2. Teaching-learning collaboration between teachers of STEM subjects and FCS teachers.
3. Update the national FACS standards to include STEM concepts.
4. Develop engaging lessons, such as challenging students to develop a new kitchen gadget.

Limitations of the Study

The Delphi survey technique is useful for gaining consensus from a knowledgeable group of people, however, limitations exist. During the duration of this study, limitations were identified. Including the participation rate, length of study and large percent of data was determined to meet consensus.

Not all participants completed all 3 rounds during the duration of this study. Delphi surveys rely on the participant's remaining interested in the study to complete all three rounds (Davis & Alexander, 2009; Hsu & Sandford, 2007; Lambrecht, 2007). The percent of participation dropped to 80% for Round 2 and 75% for Round 3. Reminder e-mails were sent before the close of each round to encourage participation. However, prior Delphi studies have shown it is common for not all participants to complete each round and this is to be expected due to length between rounds and fatigue (Skulmoski et al., 2007; Stimpson, 2010). For this study, 40-60 participants were sought with maintaining at least 15 participants through all rounds. Additionally, of the participants who agreed, almost all came from an education background (18) while only 2 participants worked in the STEM industry.

Next, this Delphi survey does not produce immediate results as a large amount of time is required from participants to complete the three rounds of survey administration (Linstone & Turloff, 1975; Skulmoski et al., 2007; Stimpson, 2010). The time between Round 1 and 2 was two months and between Round 2 and 3 an additional two months. Due to this lengthy time, some participants may experience boredom and fatigue from multiple rounds (Combs & Hall, 1994).

Lastly, as a Delphi survey is practical for interest areas with little known information, the liberal level of consensus used created a large percent of items determined to meet consensus. The liberal level of consensus was chosen based on the research of previous Delphi studies to gain a wide range of responses (Stimpson, 2010). However, the 62.5% consensus level for this study allowed for a majority of the statements to meet criteria. This shows STEM education concepts are already in place and play an important role in the curriculum, according to the expert panel in this study. In future studies, a more strict level of consensus can be used to prioritize skills, abilities, and knowledge identified in this study.

Conclusions and Recommendations

The researcher set out to study the extent to which integration of STEM education concepts into the family and consumer sciences nutrition and food science career pathway exists. There was little research done with respect to the subject and this became an impetus to gather more information. The Delphi technique became the most reasonable way to gather such information because experts from different settings that are pertinent to the study would shed information to the study.

The results of this study will help guide future curriculum development for the family and consumer science nutrition and food science pathway at the secondary level as there is little research on the integration of STEM education concepts into this field. Table 34 lists the concepts which reached the highest level of consensus in this study and should be considered by professionals in the field.

Based on the findings in this study, the following conclusions can be made:

1. Curriculum and standards can be developed and/or modified from the findings in this study to strengthen STEM skills, abilities, and knowledge in the family and consumer science nutrition and food science pathway.
2. These results will be used to generate discussion among family and consumer sciences educators for future planning and development of the nutrition and food science career pathway curriculum to enhance students' opportunities for STEM-related careers to meet twenty-first century needs.

3. The findings highlight the need to stimulate interest in STEM related careers. Themes on how this can be done include laboratory experience, field work, and attending workshops. The results indicated there is a strong need for teachers of STEM disciplines and family and consumer sciences to work together to integrate the fields to help students understand STEM careers and interest.

This research study explored how an integrated curriculum design could occur in the family and consumer sciences nutrition and food science career pathway using the Delphi method. The concepts in this study that meant the highest level of consensus can be used to determine ways an integrated curriculum design can happen between the STEM disciplines and the family and consumer sciences nutrition and food science career pathway.

Results from this study will be used to generate discussion among the family and consumer science educators for future development and planning on an integrated curriculum design. The results of this study focused on the nutrition and food science career pathway to enhance student's opportunities for STEM related careers. Further studies can narrow down the results from this study to implement integration and update family and consumer sciences standards. The reauthorization in 2018 of Carl D. Perkins Career and Technical Education Improvement Act of 2006, referred to as Perkins V, confirms career and technical education and family and consumer sciences continues to impact secondary education (Carl D. Perkins Career and Technical Education Act, n.d.).

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APPENDIX A

LETTER OF INVITATION

To: Potential Delphi Panelists

From: Ashley Q. Dabkowski, M.A.
Graduate Student in the Program of Workforce Education
Department of Career and Information Studies, College of Education
University of Georgia, Athens

Bettye P. Smith, Ph.D.
Professor in the Program of Workforce Education and Advisor
Department of Career and Information Studies, College of Education

You have been nominated by your state director as a possible participant in my Delphi dissertation research study on integrating STEM Education concepts (skills, abilities, and knowledge associated with the science, technology, engineering, and mathematics disciplines) into the nutrition and food science career pathway curriculum at the secondary level.

I am excited and pleased to extend this invitation to you to participate as a panelist in my Delphi Dissertation Research Study. I cannot identify the other participants in the study for you, inasmuch as anonymity of panelists is a vital feature of any Delphi study.

I know you are a professional with an extremely busy schedule. However, the Delphi methodology consists of three sets of questionnaires that are given to expert panelists (that's you). Responses to the questions are returned to the researcher (that's me) who analyzes the data and returns feedback to the panelists, who will each receive a final copy of the conclusions of the research.

This study will be the basis for my dissertation. It is under the direction of Dr. Bettye P. Smith. From the Department of Career and Information Studies, Dr. John Mativo, Dr. Jay Rojewski, and Dr. Robert Wicklein are also members of my dissertation committee.

The entire Delphi process will take about eight weeks, although you will only respond to one set of questions and two sets of questionnaires. This will take approximately 60 minutes of your time. Will you participate in this study? If yes, please respond to me, Ashley Dabkowski, ashleyqd@uga.edu. Should you have any questions, please feel free to call me directly at xxx-xxx-xxxx.

Thank you in advance for sharing your time and expertise, and for your contributions to this research.

Sincerely,

Ashley Q. Dabkowski

APPENDIX B

NOMINATION LETTER

NOMINATION EMAIL

To: National Association of State Administrators of Family and Consumer Sciences (NASAFCS)

From: Ashley Q. Dabkowski, M.A.
Graduate Student in the Program of Workforce Education
Department of Career and Information Studies, College of Education
University of Georgia, Athens

Bettye P. Smith, Ph.D.
Professor in the Program of Workforce Education and Advisor
Department of Career and Information Studies, College of Education

As the family and consumer sciences program director in your state, this email seeks nominations from you for NASAFCS members and secondary teachers in the nutrition and food science career pathway to participate in a research study. This Delphi study seeks to project the integration of STEM Education concepts (skills, abilities, and knowledge associated with the science, technology, engineering, and mathematics disciplines) into the nutrition and food science career pathway curriculum at the secondary level.

Therefore, will you please provide the name/s and email addresses for at least five individuals knowledgeable in and about the nutrition and food science career pathway that are best qualified to project the integration of STEM Education concepts into the curriculum?

Thank you for your help on this important contribution to the profession of family and consumer sciences education.

Sincerely,

Ashley Dabkowski
Under the direction of Dr. Bettye Smith

NOMINATION EMAIL

To: National Association of Teacher Educators for Family and Consumer Sciences (NATEFCS)

From: Ashley Q. Dabkowski, M.A.
Graduate Student in the Program of Workforce Education
Department of Career and Information Studies, College of Education
University of Georgia, Athens

Bettye P. Smith, Ph.D.
Professor in the Program of Workforce Education and Advisor
Department of Career and Information Studies, College of Education

As the family and consumer sciences teacher educator, this email seeks nominations from you for NATEFCS members and secondary teachers in the nutrition and food science career pathway to participate in a research study. This Delphi study seeks to project the integration of STEM Education concepts (skills, abilities, and knowledge associated with the science, technology, engineering, and mathematics disciplines) into the nutrition and food science career pathway curriculum at the secondary level.

Therefore, will you please provide the name/s and email addresses for at least five individuals knowledgeable in and about the nutrition and food science career pathway that are best qualified to project the integration of STEM Education concepts into the curriculum?

Thank you for your help on this important contribution to the profession of family and consumer sciences education.

Sincerely,

Ashley Dabkowski
Under the direction of Dr. Bettye Smith

NOMINATION EMAIL

To: Engineering & Technology Education Division, Association of Career and Technical Education

From: Ashley Q. Dabkowski, M.A.
Graduate Student in the Program of Workforce Education
Department of Career and Information Studies, College of Education
University of Georgia, Athens

Bettye P. Smith, Ph.D.
Professor in the Program of Workforce Education and Advisor
Department of Career and Information Studies, College of Education

As a STEM professional, this email seeks nominations from you for individuals in engineering & technology education to participate in a research study. This Delphi study seeks to project the integration of STEM Education concepts (skills, abilities, and knowledge associated with the science, technology, engineering, and mathematics disciplines) into the nutrition and food science career pathway curriculum at the secondary level.

Therefore, will you please provide the name/s and email addresses for at least five individuals knowledgeable in and about engineering & technology education that are best qualified to project the integration of STEM Education concepts into the curriculum?

Thank you for your help on this important contribution to the profession of family and consumer sciences education.

Sincerely,

Ashley Dabkowski
Under the direction of Dr. Bettye Smith

NOMINATION EMAIL

To: Nutrition, Health and Food Management, and Hospitality Management Community of the American Association of Family and Consumer Sciences

From: Ashley Q. Dabkowski, M.A.
Graduate Student in the Program of Workforce Education
Department of Career and Information Studies, College of Education
University of Georgia, Athens

Bettye P. Smith, Ph.D.
Professor in the Program of Workforce Education and Advisor
Department of Career and Information Studies, College of Education

As a nutrition, health and food management, and hospitality management professional, this email seeks nominations from you for individuals in your professional field to participate in a research study. This Delphi study seeks to project the integration of STEM Education concepts (skills, abilities, and knowledge associated with the science, technology, engineering, and mathematics disciplines) into the nutrition and food science career pathway curriculum at the secondary level.

Therefore, will you please provide the name/s and email addresses for at least five individuals in the nutrition, health and food management, and hospitality management professional field that are best qualified to project the integration/infusion of STEM Education concepts into the curriculum at the high school level?

Thank you for your help on this important contribution to the profession of family and consumer sciences education.

Sincerely,

Ashley Dabkowski
Under the direction of Dr. Bettye Smith

APPENDIX C

ROUND 1 QUESTIONS

STEM (Science, Technology, Engineering, Mathematics) Education Concepts and the Nutrition and Food Science Career Pathway: A Delphi Study

Round 1

DIRECTIONS: The nutrition and food science career pathway at the secondary level in some states such as Georgia includes three courses: *Food, Nutrition, and Wellness*; *Food and Nutrition through the Lifespan*; and *Food Science*. Table 1 below is a description of the three courses offered in the nutrition and food science career pathway at the secondary level in Georgia. A description of the courses is provided for your review as you complete the questions for this study on skills, abilities, and knowledge associated with the disciplines of science, technology, engineering and/or mathematics (STEM) and needed to pursue a related career.

In some states, science and mathematics standards are included in one or more courses in the nutrition and food science career pathway. However, these standards are included as academic rather than as an emphasis toward a STEM related career. Therefore, the focus of these questions is on skills, abilities, and knowledge associated with the disciplines of STEM as needed to pursue a related career.

Table 1

Program of Study for Secondary Nutrition and Food Science Career Pathway

Courses in the Pathway	Description of Course
Food, Nutrition, and Wellness	An essential course in understanding nutritional needs and food choices for optimal health of individuals across the lifespan. Interrelationships with wellness are explored. Leads to the advanced nutrition pathway and develops a knowledge base and the skills necessary to select among alternatives in the marketplace, with an emphasis on nutrient content, development of chronic diseases, and food safety.

Food and Nutrition Through the Lifespan	An advanced course in food and nutrition that addresses the variation in nutritional needs at specific stages of the human life cycle: lactation, infancy, childhood, adolescence, and adulthood including old age. The most common nutritional concerns, their relationship to food choices and health status and strategies to enhance well-being at each stage of the lifecycle are emphasized. Provides knowledge for real life and offers students a pathway into dietetics, consumer foods, and nutrition science careers with additional education at the post-secondary level.
Food Science	Integrates many branches of science and relies on the application of the rapid advances in technology to expand and improve the food supply. Students will evaluate the effects of processing, preparation, and storage on the quality, safety, wholesomeness, and nutritive value of foods. Building on information learned in Nutrition and Wellness, and Chemistry, this course illustrates scientific principles in an applied context, exposing students to the wonders of the scientific world. Careers will be explored.

Note: Description obtained from Georgia Department of Education, but similar in many states.

Directions: Table 2 shows the science standards whereas Table 3 shows the mathematics standards that are currently found one or more of the courses in the nutrition and food science career pathway in Georgia.

Question 1

Using the academic standards and concepts provided below in Table 2, list as many *skills*, *abilities*, and *knowledge* associated with **science** that should be included in the nutrition and food science career pathway at the secondary level to pursue a related career. There is no need to rank items; you may list more if desired.

Note: Skills, abilities, and knowledge are defined below in sections A, B, and C.

A. Skills - an observable competence to perform a learned psychomotor act which can be measured.

1.

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B. Abilities - capability to perform an observable behavior that results in an observable product.

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C. Knowledge - a body of information applied to the performance of a task.

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Table 2

Science Standards for Nutrition and Food Science Career Pathway

Standard
SCSh3. Students will identify and investigate problems scientifically.
SCSh6. Students will communicate scientific investigations and information clearly.
SCSh7. Students analyze how scientific knowledge is developed.
SCSh1. Students will evaluate the importance of curiosity, honesty, openness and skepticism in science.
SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.
SCSh4. Students will use tools and instruments for observing, measuring and manipulating scientific equipment and materials.
SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanation.
SCSh8. Students will understand important features of the process of scientific inquiry.
SC1. Students will analyze the nature of matter and its classification.
SC2. Students will relate how the Law of Conservation of Matter is used to determine chemical composition in compounds and chemical reactions.
SC3. Students will use the modern atomic theory to explain the characteristics of atoms.
SC4. Students will use the organization of the periodic table to predict properties of elements.
SC5. Students will understand the rate at which a chemical reaction occurs can be affected by changing concentration, temperature, or pressure and the addition of a catalyst.
SC7. Students will characterize the properties that describe solutions and the nature of acids and bases.

Note: Description obtained from Georgia's Academic Standards for Nutrition and Food Science Career Pathway, but similar in many states.

Question 2

Using the academic standards and concepts provided below in Table 3, list as many *skills*, *abilities*, and *knowledge* associated with **mathematics** that should be included in the nutrition and food science career pathway at the secondary level to pursue a related career. There is no need to rank items; you may list more if desired.

Note: Skills, abilities, and knowledge are defined below in sections A, B, and C.

A. Skills - an observable competence to perform a learned psychomotor act which can be measured.

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B. Abilities - capability to perform an observable behavior that results in an observable product.

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C. Knowledge - a body of information applied to the performance of a task.

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Table 3

Math Standards for Nutrition and Food Science Career Pathway

Standard
MM3P1. Students will solve problems (using appropriate technology).
MM3P2. Students will reason and evaluate mathematical arguments.
MM3P3. Students will communicate mathematically.
MM3P4. Students will make connections among mathematical ideas and to other disciplines.
MM3P5. Students will represent mathematics in multiple ways.

Note: Description obtained from Georgia's Academic Standards for Nutrition and Food Science Career Pathway, but similar in many states.

Directions: Tables 4 and 5 provide a list of the standards and concepts for the courses, *Foundations of Technology* and *Foundations of Engineering*, which are the introductory courses for the Engineering and Technology Education pathway. The two courses listed above provide the students with an overview of engineering and technology including fundamental technology and engineering literacy. Table 4 shows the technology standards whereas Table 5 lists the engineering standards. This information is provided to assist you in responding to the questions below.

Question 3

Using the academic standards and concepts provided below in Table 4, list as many skills, abilities, and knowledge associated with **technology education** that should be included in the nutrition and food science career pathway at the secondary level to pursue a related career. There is no need to rank items; you may list more if desired.

Note: Skills, abilities, and knowledge are defined below in sections A, B, and C.
A. Skills - an observable competence to perform a learned psychomotor act which can be measured.

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B. Abilities - capability to perform an observable behavior that results in an observable product.

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C. Knowledge - a body of information applied to the performance of a task.

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Table 4

Standards in the Foundations of Technology Course – STEM Career Pathway

Standard	Objectives
STEM-FET-1 Demonstrate employability skills required by business and industry.	1.1 Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities. 1.2 Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products. 1.3 Exhibit critical thinking and problem solving skills to locate, analyze, and apply information in career planning and employment situations. 1.4 Model work readiness traits required for success in the workplace including integrity, honesty, accountability, punctuality, time management, and respect for diversity. 1.5 Apply the appropriate skill sets to be productive in a changing, technological, and diverse workplace to be able to work independently, interpret data, and apply team work skills. 1.6 Present a professional image through appearance, behavior, and language.

STEM-FET-3 Identify the history of technology and engineering and its impact on society in the past, present, and future.	3.2 Describe the social, economic, and environmental impacts of a technological process, product, or system. 3.3 Explain the influence of technology on history and the shaping of contemporary issues. 3.4 Describe the relationship between the STEM cluster and society. 3.5 Evaluate the impact of science and society based on products and processes used in the real world for technological development. 3.6 Understand STEM knowledge and skills to analyze and suggest solutions to human societal problems. 3.7 Apply STEM knowledge and skills through hands-on research and lab experiments that are focused upon recreating the inventions and social solutions that were realized in the past, present, and possible future. 3.8 Identify key people who have influenced technological change. 3.9 Describe the impact of governmental and political systems on technological innovations. 3.10 Demonstrate ethical and professional engineering behavior in the development and use of technology.
STEM-FET-4 Demonstrate and follow safety, health, and environmental standards related to the Science, Technology, Engineering, and Math (STEM) workplaces.	4.1 Implement workplace and product safety standards such as OSHA, EPA, ISO, GMP, and UL. (STEM-ST3). 4.2 Accurately interpret safety signs, symbols, and labels (Hazardous Communications). 4.3 Demonstrate and incorporate safe laboratory procedures in lab, shop, and field environments. 4.4 Explain how the incorporation or lack of safety practices impact the economy and costs of safety in business and industry. 4.5 Identify, select, and use appropriate Personal Protective Equipment (PPE), follow work area organization procedures and follow Standard Operating Procedures (SOP) when performing work.

STEM-FET-5 Identify criteria of usage, care, and maintenance for tools and machines.	5.1 Identify, select, and use appropriate tools and machines for specific tasks. 5.2 Demonstrate safe use of tools and machines. 5.3 Use precision tools and instruments to measure and convert units. 5.4 Utilize appropriate computer hardware and software to compose, analyze and synthesize data to document the design process. 5.5 Apply proper maintenance techniques for tools, machines, and hardware.
STEM-FET-7 Use appropriate technology to collect, record, manipulate, analyze, and report data.	7.1 Demonstrate the ability to recognize cause and effect when faced with projects or issues. 7.2 Recognize measurable attributes in units, objects, systems, and processes in assigned activities. 7.3 Organize data and the consequences of the problems or issues, and research the material placing it in manageable formats. 7.4 Attempt to predict the outcomes based on data collected in a project or experiment. 7.5 Defend one's position based on quality collection of facts and data supporting plans, processes, and/or projects. 7.6 Draw a conclusion when confronted with data or observations that focus on the observed plans, processes, or projects at hand. 7.7 Analyze change as a result of data differences and changing environmental values. 7.8 Use qualitative and quantitative skills to conduct a simple scientific inquiry and economic analysis; use the data to draw a conclusion based on the analysis. 7.9 Recognize the value of the reiterative process to improve date and to improve the design process.

STEM-FET-8 Students design a solution to an engineering problem applying math and science principles.	8.1 Apply science and mathematics concepts and principles to resolve plans, projects, processes, issues, or problems through methods of inquiry. 8.2 Use the protocols in science and mathematics to integrate solutions related to technical or engineering activities using the content and concepts related to the situation or problems. 8.4 Communicate and collaborate with others on inquiry or resolution of issues/problems in the global community. 8.5 Defend one's solution based on quality collection of facts and data supporting plans, processes, and/or projects and communicate the solution both orally and written.
STEM-FET-9 Demonstrate the application of STEM in the real world.	9.1 Summarize and differentiate the uses of engineering and various technologies for STEM fields such as Aerospace, Automotive, Medical, Biotechnology, Energy and Power, Information and Communication, Automation and Robotics, Transportation, Manufacturing, and Construction.

Note: Description obtained from Georgia’s Academic Standards for Nutrition and Food Science Career Pathway, but similar in many states.

Question 4

Using the academic standards and concepts provided below in Table 5, list as many *skills*, *abilities*, and *knowledge* associated with **engineering** that should be included in the nutrition and food science career pathway at the secondary level to pursue a related career. There is no need to rank items; you may list more if desired.

Note: Skills, abilities, and knowledge are defined below in sections A, B, and C.

A. Skills - an observable competence to perform a learned psychomotor act which can be measured.

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B. Abilities - capability to perform an observable behavior that results in an observable product.

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C. Knowledge - a body of information applied to the performance of a task.

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Table 5

Standards in the Foundations of Engineering Course – STEM Career Pathway

Standard	Objectives
STEM-FET-1 Demonstrate employability skills required by business and industry.	1.1 Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities. 1.2 Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products. 1.3 Exhibit critical thinking and problem solving skills to locate, analyze, and apply information in career planning and employment situations. 1.4 Model work readiness traits required for success in the workplace including integrity, honesty, accountability, punctuality, time management, and respect for diversity. 1.5 Apply the appropriate skill sets to be productive in a changing, technological, and diverse workplace to be able to work independently, interpret data, and apply team work skills. 1.6 Present a professional image through appearance, behavior, and language.
STEM-FET-2 Develop an understanding of engineering and technology and describe the principal fields of engineering specializations (ex. aeronautical, automotive, chemical, civil, industrial, mechanical, computer software, electrical, and biomedical) and identify associated career tracks.	2.1 Explain a contemporary definition of engineering. 2.2 Identify education requirements for engineering occupations and locations where programs of study are available. 2.3 Match engineering job titles with qualifications and responsibilities. 2.4 Participate in activities related to career interests. 2.5 Explain how each engineering discipline will relate to a green environment and sustainability.

STEM-FET-3 Identify the history of technology and engineering and its impact on society in the past, present, and future.	3.1 Describe the history and development of engineering. 3.4 Describe the relationship between the STEM cluster and society. 3.6 Understand STEM knowledge and skills to analyze and suggest solutions to human societal problems. 3.7 Apply STEM knowledge and skills through hands-on research and lab experiments that are focused upon recreating the inventions and social solutions that were realized in the past, present, and possible future.
STEM-FET-4 Demonstrate and follow safety, health, and environmental standards related to the Science, Technology, Engineering, and Math (STEM) workplaces.	4.1 Implement workplace and product safety standards such as OSHA, EPA, ISO, GMP, and UL. (STEM-ST3). 4.2 Accurately interpret safety signs, symbols, and labels (Hazardous Communications). 4.3 Demonstrate and incorporate safe laboratory procedures in lab, shop, and field environments. 4.4 Explain how the incorporation or lack of safety practices impact the economy and costs of safety in business and industry. 4.5 Identify, select, and use appropriate Personal Protective Equipment (PPE), follow work area organization procedures and follow Standard Operating Procedures (SOP) when performing work.
STEM-FET-5 Identify criteria of usage, care, and maintenance for tools and machines.	5.1 Identify, select, and use appropriate tools and machines for specific tasks. 5.2 Demonstrate safe use of tools and machines. 5.3 Use precision tools and instruments to measure and convert units. 5.4 Utilize appropriate computer hardware and software to compose, analyze and synthesize data to document the design process. 5.5 Apply proper maintenance techniques for tools, machines, and hardware.

STEM-FET-6 Apply fundamental principles of the engineering design process.	6.1 Understand and apply the engineering design process through project based learning activities. 6.2 Conduct technical research to develop possible solutions to a stated engineering problem. 6.3 Refine a design by using technical sketches, prototypes and modeling to ensure quality, efficiency, and productivity of the final product. 6.4 Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process (optimization and iterations) in order to check for proper design and note areas where improvements are needed. 6.5 Apply engineering economics and optimal design techniques to a design solution. 6.6 Record and organize observations and test data during design evaluation. 6.7 Finalize solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, qualitative, virtual, and physical means.

STEM-FET-7 Use appropriate technology to collect, record, manipulate, analyze, and report data.	7.1 Demonstrate the ability to recognize cause and effect when faced with projects or issues. 7.2 Recognize measurable attributes in units, objects, systems, and processes in assigned activities. 7.3 Organize data and the consequences of the problems or issues, and research the material placing it in manageable formats. 7.4 Attempt to predict the outcomes based on data collected in a project or experiment. 7.5 Defend one's position based on quality collection of facts and data supporting plans, processes, and/or projects. 7.6 Draw a conclusion when confronted with data or observations that focus on the observed plans, processes, or projects at hand. 7.7 Analyze change as a result of data differences and changing environmental values. 7.8 Use qualitative and quantitative skills to conduct a simple scientific inquiry and economic analysis; use the data to draw a conclusion based on the analysis. 7.9 Recognize the value of the reiterative process to improve date and to improve the design process.

STEM-FET-8 Students design a solution to an engineering problem applying math and science principles.	8.1 Apply science and mathematics concepts and principles to resolve plans, projects, processes, issues, or problems through methods of inquiry. 8.2 Use the protocols in science and mathematics to integrate solutions related to technical or engineering activities using the content and concepts related to the situation or problems. 8.3 Explain the role of modeling and/or simulation in science and engineering. 8.4 Communicate and collaborate with others on inquiry or resolution of issues/problems in the global community. 8.5 Defend one's solution based on quality collection of facts and data supporting plans, processes, and/or projects and communicate the solution both orally and written.
STEM-FET-9 Demonstrate the application of STEM in the real world.	9.1 Summarize and differentiate the uses of engineering and various technologies for STEM fields such as Aerospace, Automotive, Medical, Biotechnology, Energy and Power, Information and Communication, Automation and Robotics, Transportation, Manufacturing, and Construction.

Note: Description obtained from Georgia's Academic Standards for Nutrition and Food Science Career Pathway, but similar in many states.

Question 5

What are some suggestions (strategies, approaches, ideas) that the family and consumer sciences education profession can do to integrate STEM education concepts into the nutrition and food science career pathway at the secondary level?

1.
2.
3.
4.
5.

APPENDIX D

COVER LETTER

Month, Day, Year

Dear Professional:

I am a graduate student under the direction of Dr. Bettye Smith in the Department of Workforce Education at The University of Georgia. I invite you to participate in a research study entitled "*Integrating STEM Education Concepts* (abilities, skills, and knowledge associated with science, technology, engineering, and mathematics disciplines) *into the Nutrition and Food Science Career Pathway: A Delphi Study."*

The purpose of this study is to project potential STEM Education concepts to infuse in the family and consumer sciences education nutrition and food science career pathway curriculum at the secondary level.

The survey for this study will use the Delphi technique. The Delphi technique is a popular method used to gain insight on a topic for future planning and development. Your participation will involve completing an online survey. This study has three separate rounds; therefore, it will be completed at three different times rather than all at one time. Each of the three rounds should take appropriately 20 minutes. Your involvement in the study is voluntary, and you may choose not to participate or to stop at any time.

There is a limit to the confidentiality that can be guaranteed when using internet communications due to the technology itself. However, once the materials are received by the researcher, standard confidentiality procedures will be employed. Results of this participation will be anonymous. Your identity will not be associated with your responses in any published format.

The findings from this project may provide information that may assist in the integration of STEM Education concepts into the nutrition and food science career pathway. There are no known risks or discomforts associated with this research.

If you have any questions about this research project, please feel free to contact me Ashley Dabkowski, ashleyqd@uga.edu and/or Dr. Bettye Smith, smithb@uga.edu. Questions or concerns about your rights as a research participant should be directed to the University of Georgia Institutional Review Board, 629 Boyd GSRC, Athens, Georgia 30602-7411; telephone (706) 542-3199; email irb@uga.edu.

By completing the online survey, you are agreeing to participate in the above described research project. Thank you for your consideration. Please keep this letter for your records.
Sincerely,

Ashley Q. Dabkowski

APPENDIX E

ROUND 2 QUESTIONNAIRE

Round 2 Instrument
Nutrition and Food Science Career Pathway and STEM (Science, Technology, Engineering, Mathematics) Education Concepts: A Delphi Study

Round 2

Section I. STEM (Science, Technology, Engineering, Mathematics) Education Concepts

Instructions:
The following statements were developed from the Round 1 questionnaire. Review the four tables and circle or mark the response level on the right according to how much you agree or disagree with the statement. Please feel free to provide comments. Please answer all questions.

Response Levels: SA – Strongly Agree
A – Agree
D – Disagree
SD – Strongly Disagree

A. Science Concepts (Skills, Abilities, Knowledge) in Nutrition and Food Science Career Pathway.

	Response			
	SA	A	D	SD
Skills Statements				
1. Use standard safety practices for all classroom laboratory and field investigations. Comments:				
2. Use tools and instruments for observing, measuring and manipulating scientific equipment and materials. Comments:				
3. Identify and investigate problems scientifically. Comments:				
4. Demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanation. Comments:				
5. Analyze how scientific knowledge is developed. Comments:				
6. Collect and organize precise qualitative and quantitative data. Comments:				
7. Evaluate the impact of food science on research, society, and the environment. Comments:				

8. Distinguish and differentiate between scientific hypothesis and theories.
Comments:

9. Communicate scientific investigations and information clearly.
Comments:

10. Explain and recognize the value of collaboration and time management.
Comments:

11. Work independently or collectively in differing roles.
Comments:

12. Evaluate the importance of curiosity, honesty, openness and skepticism in science.
Comments:

Abilities Statements

1. Demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanation.
Comments:

2. Plan and implement descriptive, comparative, and experimental investigations.
Comments:

3. Apply scientific information extracted from various sources such as news, journal articles, and current events.
Comments:

4. Present valid conclusions through methods such as lab reports, labeled diagrams, graphic organizers, journals and summaries.
Comments:

5. Draw inferences based on data related to scientific investigations.
Comments:

Knowledge Statements

1. Understand important features of the process of scientific inquiry.
Comments:

2. Explores the role of food additives, leavening agents, and processes of energy production in food.
Comments:

3. Understand the effect of pH on pathogens related to food borne illnesses.

Comments:

4. Understand foodborne illnesses and how they are traced back to the source of contamination.
   Comments:

5. Understand the digestive system and how age effects chemical absorption.
   Comments:

B. Technology Concepts (Skills, Abilities, Knowledge) in Nutrition and Food Science Career Pathway.

Response
SA A D SD

Skills Statements

1. Demonstrate employability and leadership skills required by business and industry.
   Comments:

2. Demonstrate and incorporate safe laboratory procedures in lab, shop, and field environments.
   Comments:

3. Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities.
   Comments:

4. Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products.
   Comments:

5. Exhibit critical thinking and problem solving skills to locate, analyze, and apply information in career planning and employment situations.
   Comments:

6. Given a group of food products, students should be able to properly design procedures for prepare certain nutritional meals that reflect technology changes through various historical time periods.
   Comments:

7. Create historical props or prototypes for nutritional displays and presentations.
   Comments:

8. Present a professional image through appearance, behavior, and language in the workplace and lab settings.
   Comments:

9. Demonstrate ethical and professional engineering behavior in the development and use of technology.
Comments:

10. Work independently, interpret data, and apply teamwork skills.
Comments:

Abilities Statements

1. Use commercial and residential kitchen equipment, tools, and appliances.
   Comments:

2. Use appropriate technology to collect, record, manipulate, analyze, and report data.
   Comments:

3. Understand work area organization procedures and follow Standard Operating Procedures (SOP) when performing work.
   Comments:

4. Accurately interpret safety signs, symbols, and labels (Hazardous Communications).
   Comments:

5. Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products.
   Comments:

6. Create electronic presentations, displays, and portfolios for nutrition with the use of computer software.
   Comments:

7. Apply the appropriate skill sets to be productive in a changing, technological, and diverse workplace to be able to work independently, interpret data, and apply team work skills.
   Comments:

Knowledge Statements

1. Identify and describe the history of technology and its impact on society in the past, present, and future.
   Comments:

2. Identify key people who have influenced technological change.
   Comments:

3. Describe how technological advances impact nutrition, food processing and food safety.
   Comments:

4. Trace the development food and nutrition as a result of engineering and technology advancements.
   Comments:

5. Understand how mechanization has increased food supply.
   Comments:

6. Demonstrate creativity with multiple approaches to ask challenging questions resulting in innovative procedures, methods, and products.
   Comments:

7. Attempt to predict the outcomes based on data collected in a project or experiment.
   Comments:

8. Draw a conclusion when confronted with data or observations that focus on the observed plans, processes, or projects at hand.
   Comments:

9. Evaluate the impact of science and society based on products and processes used in the real world for technological development.
   Comments:

C. Engineering Concepts (Skills, Abilities, Knowledge) in Nutrition and Food Science Career Pathway.

	Response			
	SA	A	D	SD
Skills Statements				
1. Demonstrate and follow safety, health, and environmental standards related to the engineering workplace. Comments:				
2. Model employability skills and work readiness traits required for success in the engineering workplace including integrity, honesty, accountability, punctuality, time management, and respect for diversity. Comments:				
3. Design a solution to an engineering problem applying STEM principles.				

Comments:

4. Create a display and prepare personal portfolio that represent characteristics of one's employability skills.
   Comments:

5. Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities.
   Comments:

6. Work independently, interpret data, and apply teamwork skills.
   Comments:

Abilities Statements

1. Apply fundamental principles of the engineering design process.
   Comments:

2. Describe the principal fields of engineering specializations (ex. aeronautical, automotive, chemical, civil, industrial, mechanical, computer software, electrical, and biomedical) and identify associated career tracks.
   Comments:

3. Identify the history of engineering and its impact on society in the past, present, and future.
   Comments:

4. Draw a conclusion when confronted with data or observations that focus on the observed plans, processes, or projects at hand.
   Comments:

5. Finalize solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, qualitative, virtual, and physical means.
   Comments:

6. Participate in activities related to engineering career interests.
   Comments:

7. Understand engineering knowledge and skills to analyze and suggest solutions to human societal problems.
   Comments:

8. Understand and apply the engineering design process through project based learning activities.
   Comments:

Knowledge Statements

1. Exhibit critical thinking and problem solving skills to locate, analyze, and apply information in career planning and employment situations.
   Comments:

2. Explain how the incorporation or lack of safety practices impact the economy and costs of safety in business and industry.
   Comments:

3. Explain how the creativity and systematic design approaches impact food and nutrition; consequently affect health of society's workforce.
   Comments:

4. Identify personal characteristics that employers are interested in prospective workers.
   Comments:

5. Understanding of Industrialized food systems and its impact on the nutritional health of the population.
   Comments:

6. Research and prepare presentation of engineering careers that have direct impacts on development of food and nutrition disciplines.
   Comments:

7. Conduct technical research to develop possible solutions to a stated engineering problem.
   Comments:

D. Mathematics Concepts (Skills, Abilities, Knowledge) in Nutrition and Food Science Career Pathway.

Skills Statements	Response SA	A	D	SD
1. Communicate mathematically verbally, written, and electronically. Comments:				
2. Solve mathematical problems based on field investigations and laboratory experiments Comments:				
3. Solve complete mathematical problems using appropriate technology				

Comments:

4. Represent mathematics in multiple ways.
   Comments:

5. Reason and evaluate mathematical arguments
   Comments:

Abilities Statements

1. Make connections among mathematical ideas and to other disciplines.
   Comments:

2. Ability to calculate the food cost of a meal and set a food budget for planning.
   Comments:

3. Calculate unit cost, and understand what a unit is.
   Comments:

4. Perform a variety of experiences on food science and nutrition research and present findings.
   Comments:

Knowledge Statements

1. Understand ratios, calibration, and estimation in relation to the cooking process
   Comments:

2. Understand mathematical concepts to adjust a recipe and work formulas.
   Comments:

3. Know conversions and equivalents using metric to US standard measurements.
   Comments:

Section II. Inclusion of STEM (Science, Technology, Engineering, Mathematics) Education Concepts in the Nutrition and Food Science Career Pathway

Instructions:
The following statements were developed from the Round 1 questionnaire. Review the table below and circle or mark the response level on the right according to how much you agree or disagree with the statement. Please feel free to provide comments. Please answer all questions.

Response Levels: SA – Strongly Agree
A – Agree
D – Disagree
SD – Strongly Disagree

A. Inclusion of STEM Education concepts in the Nutrition and Food Science Career Pathway

Suggestion/Recommendation/Idea	Response SA	A	D	SD
1. Provide secondary students with opportunities to participate in STEM jobs during the school year and summer. Comments:				
2. Provide opportunities for STEM conferences for family and consumer sciences education professionals. Comments:				
3. Provide opportunities for STEM workshops for family and consumer sciences students. Comments:				
4. Teaching-learning collaboration between teachers of STEM subjects and FCS teachers. Comments:				
5. Provide professional development for teachers to experience the STEM relationships with nutrition and food science career pathways to implement in classrooms. Comments:				
6. Develop integrated curriculum for family and consumer sciences with STEM related disciplines. Comments:				
7. Establish partnership with food and nutrition related industries for student learning.				

Comments:

8. Update the national FACS standards to include STEM concepts.
   Comments:

9. Create a marketing campaign showing the relationship between STEM education concepts and food science/FCS highlighting integration.
   Comments:

10. Use of resources, such as “Science and Our Food Supply” program provided by the FDA.
    Comments:

11. Provide job-shadowing and touring opportunities, such as visiting food processing plants or the local supermarkets.
    Comments:

12. Develop engaging lessons, such as challenging students to develop a new kitchen gadget.
    Comments:

13. Use project-based work, develop connections with nutrition/food science businesses and education to assist.
    Comments:

14. Connect with economics education organizations to use math in graphing food supply concepts.
    Comments:

15. Promote e-mentoring with food science educators and businesses to learn more about STEM occupations.
    Comments:

16. Provide resource materials including lessons and visuals for teachers to use to teach the lessons until they feel comfortable with the content and can create their own.
    Comments:

17. Require FACS teachers to train and earn a science based certificate as part of their pathway teaching requirements.
    Comments:

18. Webinars and conference presentations covering science content for FACS teachers.
    Comments:

19. Update lab design and equipment that accommodate STEM concepts.
    Comments:

20. Incorporate more scientific inquiry and methodology into lab activities.
    Comments:

Section III - Personal and Professional Characteristics

Instructions:

Please respond to each question. Circle the item that represents your choice.

1. What is your current employment?

Classroom K-12
Administrator K-12
Teacher Educator
State Education Agency
STEM Educator
Other

2. Gender
Male
Female

3. What is your race/ethnicity (optional)? ___________________________
Caucasian/White
African American
Latino
Other

4. Degree

Bachelor's
Master's
Ed.D.
Ph.D.

5. Age (Years)

25 to 34
35 to 44
45 to 54
55 to 64
65 to 74

6. Number of years of teaching experience (including this year) ______________________

7. Are you currently certified as a Family and Consumer Sciences teacher?

Yes
No

If no, please list your certification area. ______________________________

8. Number of years teaching Family and Consumer Science (including this year) ______

9. Number of years teaching Food Science (including this year) ______

APPENDIX F

IRB APPLICATION

Phone 706-542-3199 Office of the Vice President for Research Fax 706-542-3660
Institutional Review Board

APPROVAL OF PROTOCOL

October 15, 2014

Dear Bettye Smith:

On 10/15/2014, the IRB reviewed the following submission:

Type of Review:	Initial Study
Title of Study:	Integrating STEM (Science, Technology, Engineering, Mathematics) Education Concepts into the Nutrition and Food Science Career Pathway: A Delphi Study
Investigator:	Bettye Smith
IRB ID:	STUDY00001504
Funding:	None
Grant ID:	None

The IRB approved the protocol from 10/15/2014.

In conducting this study, you are required to follow the requirements listed in the Investigator Manual (HRP-103).

Sincerely,

Larry Nackerud, Ph.D.
University of Georgia
Institutional Review Board Chairperson