Fall 12-2022

# Factors Predicting Family and Consumer Sciences Teachers' Levels of Self-Efficacy in STEM Education

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# FACTORS PREDICTING FAMILY AND CONSUMER SCIENCES TEACHERS' LEVELS OF SELF-EFFICACY IN STEM EDUCATION

by

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A Dissertation Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY IN EDUCATION

OCCUPATIONAL AND TECHNICAL STUDIES

OLD DOMINION UNIVERSITY
December 2022

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ABSTRACT

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Education in science, technology, engineering, and mathematics (STEM) has become widely promoted in recent years. Quality STEM education could maintain or increase the number of individuals preparing for careers in these fields and increase STEM literacy for the population. Family and Consumer Sciences (FCS) education has always used science to improve home life while reinforcing technology, engineering, and mathematics principles through hands-on, relevant learning activities in the classroom. However, it is not usually recognized as a STEM subject. The purpose of this study was to determine what factors may affect FCS teachers' level of self-efficacy in teaching STEM education in order to provide supports that improve teaching practices. This quantitative study surveyed middle and high school FCS teachers in Pennsylvania using the *T-STEM Survey for Elementary Teachers*. Results were analyzed using descriptive statistics and regression analysis. The first research question explored the level of self-efficacy of FCS teachers regarding teaching STEM concepts. The second research question explored how each of the teacher demographic variables respectively predict the level of self-efficacy of FCS teachers when teaching STEM concepts. The five independent teacher demographic variables were participation in FCCLA, number of STEM courses taken, education level, number of years in teaching, and gender. Overall, FCS teachers scored highest in 21st century learning attitudes and lowest in STEM instruction. The results indicated that the

independent variable number of STEM courses taken was a significant predictor of 21st century learning attitudes ($\beta = .02$, $SE = .01$, $p = .019$).

This dissertation is dedicated my family. To my parents, you have instilled in your children the importance of hard work and getting a job done. To my sister, you listened and encouraged and always inspire me with your dedication to your family, job, education, and life. To my little love, who has been listening to me read textbooks aloud since he was born. You know more academic lingo than any other six-year-old. Thanks for all of the snuggles and for reminding me that "motivated people make it happen, and we are motivated, Mommy." And to my husband, without you, this would not have been possible. You enabled me to achieve a longtime goal, and I know that the burden it put on you was a lot at times, but you always believed in me. Thank you all for your love, support, and encouragement. Love all around.

**ACKNOWLEDGMENTS**

When I started this program, they told me it would be a marathon and not a sprint, to which I thought, “Perfect. I love marathons!” Though, this process has been more difficult than any marathon, the two yield similarities. Both require stamina. Both require determination. There is a point in both where you feel like quitting. But in both there is also an amazing reward at the end, an end that I could not have reached alone, so I would like to express my sincerest thanks to those who helped me get here.

I would like to begin by expressing my gratitude to my committee. Dr. Yen, I appreciate your willingness to guide me and value the experience and expertise that you contributed to this process. You were patient and smiling, even when I made mistakes. You made me feel like mistakes were just a part of the process. Dr. Kosloski, I understand why they start you out with the newbies. You were tough but made the content enjoyable, because your passion for the field comes through. Despite possibly being the busiest person I know, you find time to provide valuable, detailed feedback that has challenged me to be a better student and writer. Your experience, encouragement, music selections, and appropriately timed humor have been instrumental in getting me to this finish line. Dr. Reed, when I asked you to be my chair, you told me it would be my ship to steer. Thank you for letting me take the lead and for guiding me in the right direction. Your knowledge and experience have helped me to grow as an academic and writer. Thank you for your encouragement and for making me go through the APA manual, line by line. Thank you for understanding my busy life. Most especially, thank you for being on this journey with me.

To my sister, Leah, you have always been one of my biggest supporters. Whether sending punny cards or packages or listening to me ramble about my latest revision, I always feel your love and support. How lucky I am to have you as a sister and best friend. I think this calls for another trip!

Sweetheart, thank you for all you have done to support this journey over the years. I know it was not easy to hold down the fort while I was a taking class or while I was locked in a room writing, especially when I threw training for an Ironman into the equation. Thank you for listening (or at least pretending to) and for majorly stepping up the Dad game. This would not have been possible without you. You are my puzzle piece.

West, you get your Mom back, buddy. I've been a student since the day you were born. You motivate me to be the best version of myself and to keep setting new goals. Thank you for the love, the snuggles, and the slow dances in the kitchen. I love you more than anything in this world.

To my friends and coworkers, especially Robin and Jen, thank you for listening, encouraging, helping me to process information, and sometimes just joining me on a run, ride, swim, or for a few good beers.

To my cohort girls, Meg and Sue, I absolutely would not have made it through without our meet ups, phone calls, Zooms, and many beverages. And I actually would not have made it, because I never would have figured out my table of contents. So grateful for new lifelong friends. Let's celebrate!

To the rest of my family and friends, thank you for your encouragement and support. Thank you for listening and taking an interest in my research. I appreciate that you stuck by me, even after I could only talk about one thing for the past four years. I love you all and will always be grateful.

# TABLE OF CONTENTS


Page

LIST OF TABLES ........ X

LIST OF ACRONYMS ........ XI

Chapter

I. INTRODUCTION ........ 1
- STATEMENT OF THE PROBLEM ........ 3
- RESEARCH QUESTIONS ........ 3
- BACKGROUND AND SIGNIFICANCE ........ 4
- THEORETICAL FRAMEWORK ........ 10
- STEM LITERACY ........ 11
- DEFINITION OF TERMS ........ 11
- PROCEDURE ........ 13
- LIMITATIONS ........ 14
- SUMMARY AND OVERVIEW ........ 16

II. REVIEW OF LITERATURE ........ 17
- KEY LEGISLATION IN CAREER AND TECHNICAL EDUCATION ........ 19
- STEM IN THE 21ST CENTURY ........ 21
- MATHEMATICS ........ 26
- FAMILY AND CONSUMER SCIENCES ........ 28
- STEM INTEGRATION IN CTE ........ 33
- SOCIAL COGNITIVE THEORY AND SELF-EFFICACY ........ 34
- TEACHER SELF-EFFICACY ........ 36
- SUMMARY ........ 38

III. METHODOLOGY ........ 39
- RESEARCH DESIGN ........ 39
- INSTRUMENTS ........ 40
- VALIDITY AND RELIABILITY ........ 44
- PARTICIPANTS ........ 46
- VARIABLES ........ 47
- PROCEDURE ........ 48
- DATA ANALYSIS ........ 50
- SUMMARY ........ 53

IV. RESULTS ........ 55
- RESPONSE RATE ........ 56
- DESCRIPTIVE DATA ........ 57
- STATISTICAL ANALYSIS ........ 59

SUMMARY ..... 66

V. CONCLUSIONS AND RECOMMENDATIONS ..... 67
SUMMARY ..... 67
CONCLUSIONS ..... 70
RECOMMENDATIONS ..... 76

APPENDICES ..... 97
A: HUMAN SUBJECTS REVIEW APPROVAL ..... 97
B: APPROVAL TO USE TEACHER EFFICACY AND ATTITUDES TOWARD STEM SURVEY ..... 98
C: TEACHER EFFICACY AND ATTITUDES TOWARD STEM SURVEY ..... 99
D: INVITATION TO PARTICIPANTS ..... 107
E: INFORMED CONSENT ..... 108
F: CODING TABLE ..... 110

VITA ..... 112

# LIST OF TABLES

Table Page

1. T-STEM Survey Summary ........................................ 14

2. Reliability of the T-STEM Survey ........................................ 45

3. Descriptive Statistics for Dependent Variables ........................................ 59

4. Table of Effect Sizes ........................................ 59

5. Table of Means and Standard Deviations ........................................ 65

## LIST OF ACRONYMS

AAFCS- American Association of Family and Consumer Sciences

CTE- Career and Technical Education

ESSA- Every Student Succeeds Act

FCS-Family and Consumer Sciences

ITEEA- International Technology and Engineering Educators Association

NCLB- No Child Left Behind, later became the Every Student Succeeds Act

STEL- Standards for Technological and Engineering Literacy

STEM- Science, Technology, Engineering, and Mathematics

# Chapter I

## INTRODUCTION

Education in science, technology, engineering, and mathematics (STEM) has become widely promoted in recent years. It is important to our economy that schools produce students capable of success in STEM fields. Quality STEM education could maintain or increase the number of individuals preparing for careers in these fields and increase STEM literacy for the population (Stohlmann et al., 2012) because it provides students with science, mathematics, engineering, and technology instruction that build upon each other and has real-world applications (Eberle, 2010). Further, STEM education creates critical thinkers and enables innovation, which leads to new products and processes to sustain the economy (Eberle, 2010). As evidenced by the U.S. Bureau of Labor Statistics (2021), the fastest growing occupations require at least a basic, and for many a significant, understanding of STEM subjects; therefore, it is essential that as a nation, we make STEM education a top priority (Eberle, 2010).

To promote STEM learning and literacy, schools must ground STEM pedagogy in research. Gomez and Albrecht (2013) advocate for an interdisciplinary approach that allows students to make real-world connections as they prepare for STEM pathways and careers. El-Deghaidy and Mansour (2015) found that teachers acknowledge the benefits of STEM education, such as promoting 21st century skills, thinking skills, collaboration, problem solving, and research skills. They also identify that linking learning to real-life situations increases students' interest in STEM careers (El-Deghaidy & Mansour, 2015).

Programs in career and technical education (CTE) fall into eight major areas of study: agricultural education, business education, marketing education, family and consumer sciences education (FCS), trade and industrial education (T&I), health science education, engineering and technology education, and technical education (Gordon & Schultz, 2020). These areas of study share common goals: (a) provide advocacy for the profession, (b) increase the flow of new members to the profession, and (c) provide professional development, program recognition, and program improvement activities (Gordon, 2014, p. 232). FCS education, as well as other CTE subject areas, have always had both a career and an academic focus. Due in part to the No Child Left Behind Act (2002), the Carl D. Perkins Career and Technical Education Improvement Act (2006) required CTE programs to integrate career and technical skills with academic core standards. This put even more pressure on CTE subject areas to incorporate standards-based, core academic subject matter, specifically science, mathematics, reading, social studies, and technology concepts (Bland, 2008).

From its beginning, FCS education has used the resources of modern science to improve home life (Berlage, 1998), while also using principles of mathematics, engineering, and technology (Shirley & Kohler, 2012). Efforts to formally teach principles of domesticity date back to the mid-1800s, but the term home economics was not used until the early twentieth century (Berlage, 1998). The American Association of Family and Consumer Sciences (AAFCS) (n.d.) believes that through research, experiential education, and technology, FCS professionals should help people to develop the knowledge and skills required to lead better lives, be career ready, build strong families, and meaningfully contribute to communities. FCS education provides students with tasks that require them to solve real-world problems with practical reasoning in a hands-on environment (Laster & Johnson, 2001). These skills, that are also viewed as important to integrated STEM education, have lifelong value (Honey et al., 2014).

With so much overlap in content and methodology, why is FCS not perceived as a bigger part of STEM education? Do FCS teachers feel confident in their ability to teach STEM concepts? What factors influence FCS teachers' self-efficacy in STEM education?

## Statement of the Problem

The problem of this study was to identify factors that may be related to family and consumer sciences teachers' self-efficacy in teaching STEM education to provide supports that improve teaching practices.

## Research Questions

To guide this study, the following research questions were asked:

1. What is the level of self-efficacy of FCS teachers regarding teaching STEM concepts?
    a. What is the level of FCS teachers' science teaching efficacy and beliefs?
    b. What is the level of FCS teachers' science teaching outcome expectancy?
    c. What is the level of FCS teachers' mathematics teaching efficacy and beliefs?
    d. What is the level of FCS teachers' mathematics teaching outcome expectancy?
    e. What is the level of FCS teachers' perceptions of student technology use?
    f. What is the level of FCS teachers' STEM instruction?
    g. What is the level of FCS teachers' 21st century learning attitudes?
2. How will each of the teacher demographic variables (i.e., participation in FCCLA, number of STEM courses taken, education level, number of years teaching, and gender) respectively predict the level of self-efficacy of FCS teachers when teaching STEM concepts?
    a. How will each teacher demographic variable predict FCS teachers' science teaching efficacy and beliefs?

b. How will each teacher demographic variable predict FCS teachers' science teaching outcome expectancy?

c. How will each teacher demographic variable predict FCS teachers' mathematics teaching efficacy and beliefs?

d. How will each teacher demographic variable predict FCS teachers' mathematics teaching outcome expectancy?

e. How will each teacher demographic variable predict FCS teachers' perceptions of student technology use?

f. How will each teacher demographic variable predict FCS teachers' STEM instruction?

g. How will each teacher demographic variable predict FCS teachers' 21st century learning attitudes?

## Background and Significance

Innovation and invention are influential forces in the economy (Roberts, 2012). To embed these skills into the education system and preparing students to meet these demands, STEM education has become increasingly important to federal and state government and as a result, has become a focus for school districts (Roberts, 2012). In 2009, the White House launched the Educate to Innovate initiative with the goal to increase students' ability to think critically in STEM, improve the quality of mathematics and science education, and expand STEM education and career opportunities for underrepresented groups (The White House, Office of the Press Secretary, 2009). In Fiscal Year 2018, the U.S. Department of Education invested $279 million in discretionary funds for STEM education (The U.S. Department of Education, 2018). Honey et al. (2014) pointed out that there is a call to improve both the quality of instruction and the quality of the curricula.

A driving force for the national push toward STEM education is business and industry reports calling for a better equipped, 21st century workforce (National Research Council, 2010; National Research Council, 2014). Learning to memorize and reproduce knowledge does not prepare students for the emerging job markets. Instead, we need to prepare students for abstract tasks that involve communication, adaptability, gathering and interpreting data, problem-solving, self-management, and systematic thinking (National Research Council, 2014; Committee on STEM Education, 2018). Employers are looking for abstract, conceptual thinkers who can apply information to complex, real-world problems and who possess necessary soft skills such as cooperation, adaptability, and effective communication (National Research Council, 2014; Committee on STEM Education, 2018).

The goal for American education to help improve the modern workforce is not a new idea. Since the Smith-Hughes National Vocational Education Act became law in 1917, career and technical education (CTE) has supported the changing economic and social conditions in the United States (Gordon & Schultz, 2020). As CTE evolved and with the adoption of the Carl D. Perkins Vocational and Applied Technology Education Act of 1990 (Perkins II), CTE focused on accountability, post-secondary alignment, and academic integration. The Carl D. Perkins Vocational and Technical Education Act of 1998 (Perkins III) continued the focus on alignment and integration (Gordon & Schultz, 2020). The passage of the No Child Left Behind (NCLB) Act (2002) brought about many educational reforms and a shift toward standards-based core academic subjects, specifically science, mathematics, reading, social studies, and educational technology (No Child Left Behind [NCLB], 2002). Due in part to NCLB, the Carl D. Perkins

Career and Technical Education Act of 2006 (Perkins IV) required CTE programs to integrate career and technical skills with academic core standards. The Every Student Succeeds Act (ESSA), signed in 2015, required teaching all students to high academic standards to prepare them for success in college and careers. ESSA supports the integration of academic and CTE coursework, hence, in the most recent reauthorization of the Perkins Act known as Strengthening Career and Technical Education for the 21st Century Act (2018), the law (PL 115-224 [commonly referred to as Perkins V] follows those same ideals as it promotes opportunities for CTE to meet the needs of a wider range of learners, educators, and employers (Strengthening Career and Technical Education for the 21st Century Act, 2018).

To prepare students for high-skill, high-wage, high demand occupations in the global economy and to help students transition to postsecondary education and the workplace, the U.S. Department of Education, the Office of Vocational and Adult Education (OVAE), the National School-to-Work Office (NSTWO) and the National Skill Standards Board (NSSB) developed the Career Clusters in 1996 (Advance CTE, 2021). The goal of these Clusters is to bridge secondary and postsecondary programs of study and to create individualized student plans of study to improve academic and career success (Advance CTE, 2021). There are 16 Career Clusters in the National Career Clusters Framework. These Clusters are Agriculture, Food, and Natural Resources; Architecture and Construction; Arts, A/V Technology, and Communications; Business Management and Administration; Education and Training; Finance; Government and Public Administration; Health Science; Hospitality and Tourism; Human Services; Information Technology; Law, Public Safety, Corrections and Security; Manufacturing; Marketing; Science, Technology, Engineering, and Mathematics; and Transportation, Distribution, and Logistics (Pathways to College and Career Readiness Career Clusters, n.d.).

Casale-Giannola (2011) described the following benefits of CTE: differentiated instruction, real-life connections, opportunities for active learning, repetition and practice, cooperative learning, and meaningful teacher-student relationships. Bland (2008) stated that though CTE has historically prepared thousands of students for various occupations after high school, at present, CTE courses enhance and reinforce the teaching of academic core courses such as mathematics, science, and English through theoretical and conceptual knowledge that can be applied to real-world settings. Similarly, STEM pedagogy supports a project-based approach requiring students to apply content knowledge to solve problems.

There are many definitions of STEM education, but there are similar characteristics in the literature regarding design and implementation (Honey et al., 2014). STEM education should provide students with authentic experiences and the opportunity to solve problems in-depth (Honey et al., 2014). Sanders (2008) explained STEM education as interdisciplinary and stated that it should include an approach to teaching and learning that incorporates two or more of the STEM subject areas and/or a STEM subject and one or more other school subjects. Gomez and Albrecht (2013) also supported an interdisciplinary approach because it helps students to make real-world connections, preparing them for STEM careers and pathways. Moore et al. (2014), in their K-12 STEM education framework, found the following to be important aspects of STEM: the inclusion of mathematics and science, a student-centered approach, engaging and motivating lessons, including the engineering process, the ability for student to learn from their mistakes, and teamwork.

The U.S. Department of Education and Office of Innovation and Improvement (2016) also supports an integrated approach because solutions to most global problems concerning energy, health, and the environment require an interdisciplinary perspective. Recent educational changes such as the *Next Generation Science Standards* (NGSS Lead States, 2013) and *Common Core State Standards for Mathematics* (CCSSM) also support strengthening STEM programs by intentionally integrating instruction and curricula (National Academy of Sciences, 2012). Similarly, the International Technology and Engineering Educators Association (ITEEA) developed *Standards for Technological and Engineering Literacy* (STEL) which help educators better understand technology and engineering education while promoting interdisciplinary instruction for all students (ITEEA, 2020). The STEL standards emphasize that every human activity depends on technology and engineering; therefore, it is important for people to understand technology's impact on individuals, society, and the environment, as well as how technology extends human capabilities (ITEEA, 2020).

The NGSS provide educators with opportunities to make connections between disciplines, integrate STEM learning, and build critical-thinking skills. These ideas are foundational to family and consumer sciences (FCS) education (Deaton et al., 2018). Since its beginning, FCS education has focused on the utilization of resources of modern science to improve home life (Berlage, 1998). The American Association of Family and Consumer Sciences (AAFCS) defines FCS as a body of skills, research, and knowledge focused on helping people make informed life and work decisions based on science (n.d.). The primary subjects taught in FCS are culinary arts, hospitality and tourism, education and training, food science and nutrition, health management and wellness, housing and interior design, human/child development and family relations, personal and family finance, and textiles, apparel, and retailing (AAFCS, n.d.).

Shernoff et al. (2017) believe that integrated STEM is not only about the STEM disciplines, but that it is "rooted in project- and problem-based learning, student-centered pedagogy, and 21st century transferrable skills" (p. 4). It promotes students as active, inventive, creative learner who think critically (Shernoff, et al., 2017). These are also the tenants of FCS education. AAFCS believes that through research, experiential education, and technology, FCS professionals should help people to "develop the essential knowledge and skills to lead better lives, be work and career ready, build strong families, and make meaningful contributions to communities" (AAFCS, n.d., para. 2). Laster and Johnson (2001) pointed out important skills that are learned through FCS education. These skills are also viewed as important in STEM education. Practical reasoning is used throughout FCS education, as students are provided with tasks that require them to consider contextual factors, valued ends, alternative actions, and consequences (Laster & Johnson, 2001). Practical reasoning, along with social and intellectual processes, are used to solve real-world problems in hands-on experiences. Courses focus on developing critical thinking and ethical sensitivity (Laster & Johnson, 2001). These skills have lifelong value.

To provide in-depth, authentic, problem-based STEM education, teachers need the necessary skills. They must feel comfortable creating a classroom environment that is student-centered. Gagné (2007) stated that teachers can play the role of a catalyst in a student's talent development process. To this end, teachers can facilitate or impede students' STEM talent (Margot & Kettler, 2019). A quality STEM program would facilitate students' talent development in science, technology, engineering, and mathematics; therefore, the teacher plays an important role (Margot & Kettler, 2019). Research showed that teachers recognize the value of STEM education and acknowledge its importance in promoting 21st century skills (El-Deghaidy & Mansour, 2015). Findings also showed that teachers have concerns that they are underprepared to use STEM applications within their classrooms (El-Deghaidy & Mansour, 2015).

## Theoretical Framework

Kennedy and O'Dell (2014) encourage those involved in research, policy development, and the teaching of STEM disciplines to recognize the importance of STEM education as it prepares students for global citizenship. STEM education should lead to STEM literacy, which is the ability to apply concepts from STEM to solve problems using a transdisciplinary approach (Jackson & Mohr-Schroeder, 2018). Currently, there is not a single definition for STEM literacy, but most definitions address societal and economic needs but do not cover personal needs (Zollman, 2012). Zollman (2012) believes that to have a thorough definition of STEM literacy, all three learning domains (cognitive, affective, and psychomotor) are necessary. His definition focuses on literacies of science, technology, engineering, mathematics; personal, societal, and economic needs; and cognitive, affective, and psychomotor learning domains (Zollman, 2012). STEM educators need to be both STEM literate and comfortable with STEM methods to be successful. Along with content and pedagogy, there must be an emphasis on investigation and analysis of science questions (Zollman, 2012). Han et al. (2015) found that even after teachers demonstrated a conceptional understanding of STEM, it was difficult for them to implement the student-centered teaching style required for successful STEM integration.

Research on self-efficacy originated with Bandura (1977) and his social cognitive theory. There is not a single, agreed upon method to measure teacher efficacy because the field is constantly changing (Skaalvik & Skaalvik, 2010). Seals et al. (2017) defined teaching efficacy as a teacher's belief that they can or cannot be effective in teaching their students. They based their beliefs of teacher efficacy on Bandura's original four sources of self-efficacy: master of past experiences or prior success on a similar task, physiological or emotional benefits from completing a task, experience gained by watching others do a task, and what others say about the task or your ability to complete the task (Bandura, 1977). Additional studies have used these sources of self-efficacy to determine teacher efficacy (Seals et al., 2017). As Ross et al. (1996) explored the topic, they found that teacher perceptions of student engagement were a significant predictor of teacher efficacy and thus a teacher's efficacy should be evaluated in specific contexts while teaching specific content.

## STEM Literacy

The overall purpose of STEM education is to further develop a STEM literate society (Bybee, 2010). Bybee (2010) defines STEM literacy as an individual's knowledge, attitudes, and skills needed to identify questions and problems in the world and draw evidence-based conclusions about STEM-related issues. As teachers across subject areas are encouraged to integrate STEM into their curriculum, it will become even more important for teachers to be both STEM literate and comfortable teaching using STEM methods. Family and consumer sciences education is a natural fit for integrated STEM education, not only because of the STEM-related content, but also because of the hands-on, problem-based, exploratory curriculum. This study is important because it may validate the value of family and consumer sciences education as it relates to integrated STEM education.

## Definition of Terms

*21st Century Learning Attitudes*- attitudes that promote students as active, inventive, creative learners who think critically (Shernoff, et al., 2017). *T-STEM Survey* questions focused on whether or not student have opportunities to produce high quality work, set their own learning goals, manage time and prioritize assignments, and work with others (Friday Institute for Educational Innovation, 2012).

*Career and Technical Education (CTE)-* organized educational programs offering a sequence of courses directly related to the preparation of individuals in paid or unpaid employment and in current or emerging occupations requiring other than a baccalaureate or advanced degree. Should include competency-based applied learning that contributes to an individual's academic knowledge, higher-order reasoning, problem-solving skills, work attitudes, general employability skills, and the occupational specific skills necessary for economic independence as a productive and contributing member of society (Gordon, 2014, p. 457)

*Family and Consumer Sciences (FCS)-* - a 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. The field represents many areas, including human development, personal and family finance, housing and interior design, food science, nutrition, and wellness, textiles and apparel, and consumer issues. (American Association of Family and Consumer Sciences, n.d.)

*Project-based* - approach that requires students to apply content knowledge to solve problems (Bell, 2010)

*Problem-based-* learner-centered approach that empowers learners to research, integrate theory and practice, and apply knowledge and skills to develop solutions to defined problems (Savery, 2015).

*STEM education* - use of science, technology, engineering, mathematics, and their associated practices, to create student-centered learning environments in which students investigate and engineer solutions to problems, and construct evidence-based explanations of real-world phenomena (U.S. Department of Education, 2016)

*STEM literate* - (1) awareness of the roles of science, technology, engineering, and mathematics in modern society; (2) familiarity with at least some of the fundamental concepts from each area; and (3) a basic level of application fluency (Honey et. al, 2014 p.34)

*STEM talent development* - emergence of a diverse and STEM-ready talent pool with the knowledge, skills, and mindsets needed to secure and succeed in careers today and in the future (STEMconnector, n.d.).

*Teacher efficacy* - the teacher's perception of his or her own ability to influence student learning and achievement (Skaalvik & Skaalvik, 2010).

*Technology use*- frequency that teachers perceive students use instructional technology to communicate, collaborate, research, simulate, solve-problems, and use higher-order thinking (Friday Institute for Educational Innovation, 2012). This is how technology use is defined on the *T-STEM Survey*, but ITEEA (2020) defines technology as the human designed world, which encompasses the many tools, materials, and equipment that FCS teachers regularly use in their classrooms.

## Procedures

This descriptive, quantitative study surveyed FCS teachers in Pennsylvania using the *T-STEM Survey for Elementary Teachers* (Friday Institute for Educational Innovation, 2012) to determine their level of self-efficacy when teaching STEM concepts. It also sought to identify factors that impact their level of self-efficacy to provide supports that improve teaching practices. The survey includes questions on science teaching efficacy and beliefs, science teaching outcome expectancy, mathematics teaching efficacy and beliefs, mathematics teaching outcome expectancy, student technology use, STEM instruction, and 21st century learning attitudes (Table 1).

**Table 1**

*T-STEM Survey Summary*

| Construct | Measurement Application |
|---|---|
| Personal Teaching Efficacy and Beliefs | Self-efficacy and confidence related to teaching the specific STEM subject |
| Teaching Outcome Expectancy Beliefs | Degree to which the respondent believes student-learning in the specific STEM subject can be impacted by actions of teachers |
| Student Technology Use | How often students use technology in the respondent's classes |
| STEM Instruction | How often the respondent uses certain STEM instructional practices |
| 21st Century Learning Attitudes | Attitudes toward 21st century learning |

Adapted from the Friday Institute for Educational Innovation (2012)

A description, invitation, consent form, and link to the survey were sent out via email through Pennsylvania's FCCLA facilitator, the FCS content advisor for the Pennsylvania Department of Education, and through the Pennsylvania Association of FCS (PAFCS) to their respective listservs. The survey was emailed to Pennsylvania FCS teachers in April. Descriptive statistics and simple linear regression models were used to analyze the data.

## Limitations

Results from this survey, the *T-STEM Survey for Elementary Teachers,* give only quantitative data on teacher attitudes toward STEM. This version of the survey was selected because it covers both science and mathematics constructs. In this survey, STEM teaching self-efficacy is broken into nine separate dependent variables, and these include science teaching efficacy and beliefs, science teaching outcome expectancy, mathematics teaching efficacy and beliefs, mathematics teaching outcome expectancy, student technology use, STEM instruction, 21st century learning attitudes, teacher leadership attitudes, and STEM career awareness. Teacher leadership attitudes and STEM career awareness were eliminated from the survey leaving seven dependent variables. Results are limited to the factors measured by this survey. The survey is validated at the construct-level, not at the item-level. Therefore, it is recommended that comparisons be made at the construct-level and conclusions are not based on a single question.

Sampling will be voluntary, which does not allow the researcher to control the sample size. It can pose potential problems, such as the sample may not be representative of the population and the data may not be generalizable (Rosenthal & Rosnow, 2008). People electing to participate may hold strong opinions, have a greater interest in the topic, or be more highly motivated than the population (Rosenthal & Rosnow, 2008). Rosenthal and Rosnow (2008), also found that volunteers tend to be better educated, have higher social-class status, seek social approval, and be more intelligent than nonvolunteers. Further research may benefit from stratifying the sample or conducting a random sample. The field of FCS is predominately white and female; therefore, the current study may not be generalizable to the entire population of FCS teachers. Participants will self-report the number of STEM courses that they took in college. Participants may find this confusing, because they may be unsure what to consider a STEM course, despite it being defined in the survey. It may also be difficult for them to remember the courses that they took throughout their undergraduate, masters, and doctoral coursework.

Because this survey will be self-reported, Rosenthal and Rosnow (2008) caution that respondents may not know the right answers to some of the questions they are asked, so they can only guess the answers. Nisbett and Wilson (1977) argued that people cannot realistically look within themselves apart from the immediate situation, so when self-reporting, an experience may not be equivalent to another person's rating even if they both give the same numerical response. Bartoshuk (2000) suggests using multiple methods such as complimenting the self-reported survey with an interview.

## Summary and Overview

Chapter II will review the literature on STEM education, including integrated STEM recommendations, to determine what relevant research has been performed. Social cognitive theory and teacher self-efficacy will be explored to see what factors impact FCS teachers' self-efficacy regarding STEM concepts. It will also review the foundations of career and technical education, the role of integrated STEM, and will particularly focus on family and consumer sciences and its role in integrated STEM education. Chapter III will address the methods and procedures used to conduct this study. Chapter IV will present the findings of this study. Chapter V will summarize the results of the research, draw conclusions to the findings, and list recommendations based on these conclusions.

# Chapter II

# REVIEW OF LITERATURE

A review of literature was conducted to examine the development of career and technical education and its connection to science, technology, engineering, and mathematics (STEM) education. There are gaps in the research on STEM education in CTE, and even more so in FCS. The literature review is organized around the research questions and variables. This chapter summarizes career and technical education, including the history, development, and key legislation. The development of education in STEM will be explained as well as an overview of STEM frameworks, followed by a history of family and consumer sciences education. The connection between STEM and FCS will be explained. An overview of Bandura's social cognitive theory and self-efficacy will be provided, followed by factors that impact teachers' levels of self-efficacy.

## Development of CTE in the United States

The history of career and technical education (CTE) demonstrates content overlap with STEM disciplines and similar career and workforce connections. CTE, as it is currently recognized, has evolved over centuries. According to the American Vocational Journal (1976), the right to free public education for children was stressed early in the United States, as there was a need to educate future leaders. As early as the 1900s, Pestalozzi espoused some of the core tenants of the CTE that we know today (Gordon & Schultz, 2020). He proposed children need to both think and do (Gutek, 1999). Federal CTE policy has developed in response to changing U.S. economic and social conditions and, as a result, CTE has undergone many changes (Gordon & Schultz, 2020). Nevertheless, the goals remain the same; programs strive to develop a highly skilled workforce to increase the quality of life for workers and the economy of the nation.

In the early 19th century, the workforce and the public education system began collaborating to train workers for a variety of jobs (*Independent Action*, 1976). Schools began specializing in training students to enter certain areas of the workforce, creating the basic framework for career and technical education (*Independent Action*, 1976). The Morrill Act of 1862 resulted from the need for trained workers in agriculture and industry and established land-grant institutions (Gordon & Schultz, 2020). Universities integrated academics and became partners in vocational training and education through the land-grant mission (Gordon & Schultz, 2020). The goal of land-grant schools was to prepare experts to educate the people, primarily by supporting farmers and agriculture, but also through home economists' efforts to educate housewives in better nutrition, child-rearing, and homemaking (Gordon & Schultz, 2020).

The first manual training school, established in St. Louis, Missouri, in 1879, set the foundation for modern career and technical education. The school combined hands-on learning with classroom learning (*Vocational Age*, 1976). Charles Prosser was an advocate for integrating CTE into general education, and his sixteen theorems were instrumental in the formation of vocational education (Gordon & Schultz, 2020). John Dewey also believed that traditional education did not provide skills and attitudes needed for the workplace (Gordon & Schultz, 2020). He also believed that hands-on, experimental work would prepare students to understand the science and processes used in work while instilling favorable group dynamics and that this could be a means to overcome social predestination (Gordon & Schultz, 2020).

Women also played a major role in the formation of CTE. Beginning in 1898, a committee spearheaded by Ellen Richards met in Lake Placid to discuss economic and social issues of the home, considered courses of study in relation to the home economics movement, studied professional training of home economics teachers, and identified graduate research in applied sciences (*Vocational Age*, 1976). By 1900, domestic science was being taught in the public-school curriculum (*Vocational Age*, 1976). In 1909, Ellen Richards was elected president to the newly created American Home Economics Association whose goal was to improve living conditions in the home, industry, and community (*Vocational Age*, 1976). This organization would become the American Association of Family and Consumer Sciences in 1994 to better reflect the "vastness of the field and to highlight its mission: to improve the lives of individuals, families, and communities" (Gordon & Schultz, 2020, p. 235).

## Key Legislation in Career and Technical Education

Over time, though CTE has evolved and placed a greater emphasis on STEM education, the career and workforce connections have remained the same (Dougherty & Harbaugh Macdonald, 2020). The Smith-Hughes Act of 1917 provided the first federal money for secondary vocational education in agriculture, homemaking, and trade and industrial education; however, it also contributed to the isolation of vocational education from the general education curriculum (Gordon & Schultz, 2020). The George-Barden Act of 1946 more than doubled the federal dollars for vocational education to provide skills to veterans returning from World War II (Calhoun & Finch, 1982). The Vocational Education Act of 1963 expanded services to include all citizens (Gordon & Schultz, 2020). The Vocational Education Amendment of 1968 was the first to reference postsecondary students (Forsythe & Weintraub, 1969). The Vocational Education Amendments of 1976 promoted overcoming gender discrimination in vocational education programs (Gordon & Schultz, 2020).

State and federal legislation have helped to stimulate these innovative approaches. With the Carl Perkins Vocational Education Act of 1984 and the Carl D. Perkins Vocational and Applied Technology Education Act of 1990, modern vocational education took shape (ACTE, 2019). This legislation emphasized accountability, alignment between secondary and postsecondary, academic integration, and business partnerships (ACTE, 2019). Beginning with the enactment of Perkins III, CTE classes became responsible for increasing students' academic performance (Stone et al., 2006). Perkins IV brought about change, as it required a state performance accountability system to promote CTE program improvement. Federal funding depended on meeting performance goals, which included student achievement in math and reading/language arts (ACTE, 2019).

The School-to-Work Opportunities Act of 1994 linked work-based and school-based learning with industry partnerships (Gordon, 2014). The No Child Left Behind (NCLB) Act of 2001 was adopted to improve the quality of education and to increase students' acquisition of the basic skills for success (U.S. Department of Education, 2004). This legislation held schools accountable for student progress by requiring annual testing in language arts, reading, and mathematics (U.S. Department of Education, 2004), making it even more important for CTE to support these subject areas within their curriculum.

In 2018, Perkins V made important updates to allow states and local recipients more flexibility, more streamlined processes, and a competitive grant program (ACTE, 2019). Perkins V provides money for innovation grants (Hyslop, 2018). These grants can be used to "create, develop, implement, replicate, or take to scale evidence-based, field-initiated innovations to modernize and improve effectiveness and alignment of CTE" (Hyslop, 2018, p. 137). They can also be used to improve student outcomes in CTE and evaluating innovations (Hyslop, 2018). Perkins V allows local funds to be used for professional development for all school staff to support individualized academic and CTE instructional approaches (Hyslop, 2018). This includes the integration of academic and CTE standards into curricula, which includes STEM integration.

Perkins V also supports the integration of academic skills into CTE programs of study to meet the academic standards of Elementary and Secondary Education Act (Hyslop, 2018).

## STEM in the 21st Century

The idea of STEM education has been contemplated since the 1990s as employers sought workers that could use judgement and make decisions rather than complete rote tasks (Commission on the Skills of the American Workforce, 1990). The National Academy of Engineering and the National Research Council (2014) identified the following goals for students: STEM literacy, 21st century competencies, workforce readiness, interest in STEM, engagement, and making connections between disciplines. The goals for teachers include increased STEM content knowledge and pedagogical content knowledge. Both CTE and STEM education promote student-centered, project-based, hands-on learning (Asunda, 2014; Merrill, 2016; Stone, 2011; Wu-Rorrer, 2017). As the United States shifts from a manufacturing-based economy to one focused on service and information, a shift in education and training is needed (Gordon & Schultz, 2020). Generally, computer technology and health fields, considered to be science, technology, engineering, and mathematics (STEM) fields, have the highest projected growth rates (Gordon & Schultz, 2020). The Smithsonian Science Education Center (2020) found that STEM-related jobs grew at three times the rate of non-STEM jobs between 2000 and 2010. The United States Bureau of Labor Statistics (2021) expects a 10.5% increase in STEM occupations between 2020 and 2030. These fields have a variety of education and training requirements (Gordon & Schultz, 2020). CTE is a perfect fit integrating STEM education (Merrill, 2016; Stone, 2011). CTE can propel students into STEM programs at technical schools, community colleges, and four-year colleges and universities, but they can also fill the training void that exists for half of the STEM jobs that are available to workers without a four-year college degree (Rothwell, 2013).

The Commission on the Skills of the American Workforce (1990) recommended including problem-solving and reasoning skills in the curriculum for all students. They also encouraged using performance, portfolio, and project examinations to assess important skills instead of standardized testing because these methods of assessment provide a clearer picture of student learning (Commission on the Skills of the American Workforce, 1990). These suggestions are still used in traditional CTE programs. Gordon & Schultz (2020) further validate this suggestion when they describe CTE as more challenging, academic, and relevant in the 21st century. Bland (2008) highlights that CTE courses prepare students to pursue academic and technical studies at the postsecondary level by helping them discover the connection between their current studies and their future career. Students enrolled in CTE courses showed that they had developed problem-solving, project completion, research, mathematics, college application, work-related, communication, time management, and critical thinking skills throughout high school (ACTE, 2017). Additionally, CTE courses provide opportunities for student to work alongside practicing professionals in an applied setting to enhance their employability skills (Bland, 2008).

To provide all students with the necessary skills to excel in the high-paid, highly rewarding fields of science, technology, engineering, and mathematics (STEM), the Educate to Innovate initiative was launched in 2009 with the goal of moving American students up in the worldwide science and mathematics rankings (The White House, Office of the Press Secretary, 2009). Funding priorities included increasing the federal investment in STEM and preparing 100,000 new and effective STEM teachers trained to create project-based and hands-on educational experiences that promote a love of learning (The White House, Office of the Press Secretary, 2009).

Proponents of STEM education not only believe that students will be better prepared for advanced education or jobs in STEM fields, but that students benefit from experiencing real-world problems (Brown et al., 2011). As STEM education becomes a greater focus for schools and teachers, it has become important to define STEM education (Brown et al., 2011). The term STEM is often defined as including science, technology, engineering, and mathematics but has also been defined as an integrated approach to teaching and learning, where discipline-specific content is not divided (Merrill, 2009). Others refer to a primary aspect of STEM education being that it crosses boundaries and encompasses real-world, problem-based learning (English, 2016). Merrill (2009) further emphasized that STEM education should be innovative as it seeks to solve human wants and needs. Kennedy and Odell (2014) identify high quality STEM education programs to include (a) integration of technology and engineering into science and mathematics curriculum at a minimum; (b) promote scientific inquiry and engineering design, include rigorous mathematics and science instruction; (c) collaborative approaches to learning, connect students and educators with STEM fields and professionals; (d) provide global and multi-perspective viewpoints; (e) incorporate strategies such as project-based learning, provide formal and informal learning experiences; and (f) incorporate appropriate technologies to enhance learning.

Integrated STEM involves intertwining the content and concepts from multiple STEM disciplines naturally, usually within the context of a problem, project, or task (Nadelson & Seifert, 2017). These problems have multiple solutions and require applying knowledge and practices from various STEM disciplines (Nadelson & Seifert, 2017). Wells (2016) stresses that technological and engineering design-based learning are foundations of integrated STEM and that intentional, hands-on experiences and experiential learning promote knowledge construction. In contrast, segregated STEM applies the knowledge and practice of one STEM subject area and typically has a single, known answer (Nadelson & Seifert, 2017). Segregated STEM focuses on content taught through direct instruction (Nadelson & Seifert, 2017). Currently, STEM in the workforce and STEM in research, industry, and society is integrated, unlike the STEM in K-12 schools, which is more segregated (Nadelson & Seifert, 2017). This contrast produces students who are unprepared to meet workforce challenges instead of those ready to solve real-world, STEM-related issues (Nadelson & Seifert, 2017). In addition to developing skills needed in the workforce, an integrated STEM approach allows students to develop a deeper understanding of STEM concepts and processes because they are applying knowledge from across STEM disciplines (Nadelson & Seifert, 2017). The Center or Occupational Research and Development (1999a, 1999b) made a similar proposal and emphasized the need for students to understand both career specific skills and the academic principles behind them. They suggested structuring learning to match students' learning styles within a hands-on, contextual environment (CORD, 1999a; CORD, 1999b). Much like proponents of STEM education, CORD advocates for applied academics and maintains that academic rigor must introduce real-world examples, applications, and problems that incorporate laboratory activities and equipment familiar to life and to work applications (CORD, 1999a; CORD, 1999b).

Wells (2016) supports an integrated STEM model that uses the STEM disciplines with equal intent. His PIRPOSAL model is a conceptual and pedagogical framework that uses design-related questioning to transition students through multiple phases of the model, while identifying an engineering solution that will solve a human want or need. The eight phases represented are problem identification, ideation, research, potential solutions, optimization, solution evaluation, alterations, and learned outcomes (Wells, 2016).

Kelley and Knowles (2016) illustrated their own framework that looks like a block and tackle of four pulleys that would lift a load. Their illustration integrates situated learning, engineering design, scientific inquiry, technological literacy, and mathematical thinking. The community of practice joins the four STEM disciplines. The authors do not suggest that STEM learning experiences must include all four STEM disciplines but suggest that STEM educators should have a strong understanding of interdisciplinary connections (Kelley & Knowles, 2016).

Integrated STEM requires general knowledge and practices from multiple disciplines (Nadelson & Seifert, 2017). Any CTE program can incorporate STEM education (Stone, 2011). However, though all CTE programs address some aspects of science, mathematics, and technology, most do not focus on engineering. Within CTE, curriculum integration helps students make connections between academic subjects (Stone, 2011). Integrated learning models are context-based and try to fit traditional academic subjects, especially STEM, into the CTE curriculum by starting with the CTE curriculum and enhancing the academic content naturally occurring in it. This is done without sacrificing CTE content while retaining rigor as academic skills are applied to real-world problems (Stone, 2011). Generally, the problem is not finding areas to embed STEM learning in these CTE programs, but how to support teachers move to integrate STEM into their classrooms (Merrill & Lawver, 2019).

The *Common Core State Standards for Mathematics* (n.d.) include eight standards for mathematical practice that make connections between the mathematics taught in the classroom and real-world problem-solving applications. The *Next Generation Science Standards* (NGSS) support integrating STEM and the NGSS framework provides opportunities for students to engage in engineering and technology to deepen their understanding of science in different contexts (NGSS Lead States, 2013). The International Technology and Engineering Educators Association (ITEEA) developed *Standards for Technological and Engineering Literacy* (STEL) which help educators better understand technology and engineering education while promoting interdisciplinary instruction for all students (ITEEA, 2020).

## Mathematics

Math-in-CTE is an experimentally tested model of teaching embedded mathematics through high school occupational education (Stone et al., 2006). In 2000, the National Council of Teachers of Mathematics (NCTM) issued a report that identified mathematics as a basic skill for industry and emphasized that mathematical literacy is necessary for anyone entering a workplace or seeking career advancement (Stone et al., 2006). Further, higher wages depend on the ability to think mathematically, but only 18% of 12th-grade students were proficient or above in mathematics in a study by Stone et al. (2006). Analyses of other data revealed that only 30% of all students complete the minimum courses recommended for college entrance, and nearly one-half of postsecondary students require remedial coursework once they get to campus (Stone et al., 2006). Reform has been called for, but little improvement occurred from 1990 to 2000 (Stone et al., 2006).

Simply requiring more mathematics courses in high school, though the likely choice, may not be effective (Stone et al., 2006). A study of teaching practices across many countries found that teachers in the United States focus more on low-level mathematics skills, whereas high-achieving countries emphasized conceptual understanding, procedural skill, and challenging content (Stone et al., 2006). The techniques used by higher-achieving countries are techniques native to career and technical education (Stone, 2011, Stone et al., 2006). Similarly, the applied academics movement showed that students who had previously performed poorly in abstract math and science courses were highly successful when taught in a hands-on, applied format (CORD, 1999a; CORD, 1999b). Thus, increasing mathematics skills by embedding mathematics into CTE coursework could be effective (CORD, 1999a; CORD, 1999b). Because CTE serves large numbers of students who are not as successful in a traditional academic environment, this could be a way to help improve mathematics scores for this group, helping to close the achievement gap between this group and those in a more traditional academic setting (Stone et al. 2006).

The Stone et al. (2006) study sought to determine if "students enrolled in high school CTE courses, who are more explicitly taught mathematics concepts embedded in the curriculum, will develop a deeper and more sustained understanding of mathematical concepts than those students who participate in the traditional CTE curriculum" (p. 65). Through the analysis of this study, core principles emerged. First, there is a need to develop and sustain a community of practice among teachers. Next, it is important to begin with the CTE curriculum and not the mathematics curriculum. Then, educators need to understand that mathematics is essential in the workplace, and then maximize mathematics in the CTE curriculum (Stone et al., 2006). Finally, recognize that CTE teachers are not mathematics teachers. These findings are important because they show that integrating mathematics into the CTE curriculum can be a successful way to improve students' overall achievement in mathematics. This integration did not have a negative effect on skill development but did require extensive training for all teachers involved (Stone et al., 2006).

## Family and Consumer Sciences

CTE encompasses non-occupational CTE, which includes FCS education. FCS is more than a program area within CTE as Palombit (2019) identifies it as a "global discipline and profession that extends into multiple practice settings including cooperative extension, business and industry, government, and health and human services" (p. 17). Further, the FCS body of knowledge has been "built through science, research, and professional collaboration between researchers and practitioners" (Palombit, 2019, p. 17). FCS is an interdisciplinary field that includes eight content areas that align with CTE Career Pathways, supporting workforce and economic needs (Palombit, 2019). According to Palombit (2019), these content areas include "(a) culinary arts, hospitality, and tourism; (b) education and training; (c) food science and nutrition; (d) health management and wellness; (e) housing and interior design; (f) human/child development and family relations; (g) personal and family finance; (h) textiles, apparel, and retailing" (p. 17).

Regarded as the founder of FCS, Ellen Swallow Richards was the first female to graduate with a chemistry degree from Vassar College, and the first female accepted into the Massachusetts Institute of Technology (MIT) where she would later teach (White & White, 2018). Richards later founded the American Home Economics Association, now the American Association of Family & Consumer Sciences (Deaton et al., 2018). She created the foundation for modern FCS and advocated for the application of scientific and management principles in the home and in the workplace, principles that have reentered national education discussions with STEM integration (Deaton et al., 2018). The name of the field was changed from home economics to family and consumer sciences in 1994, to more accurately reflect the complexity of the profession as it evolved to meet the social and economic challenges facing individuals, families, and communities today (AAFCS, n.d.).  Like any other applied science, FCS has evolved with society and technology to emphasize issues critical to successful living and working in the 21st century global society (AAFCS, n.d).

A typical goal of elective subjects, such as FCS, is to increase students' overall academic success by drawing connections between courses and other academic subjects (Carter et al., 2015). Although FCS educators mainly focus curriculum on the *National Standards for Family and Consumer Sciences* (NASAFACS, 2008-2018), they are also encouraged to find opportunities to draw connections with STEM standards to provide more STEM learning opportunities for students (Deaton et al., 2018). Deaton et al. (2018) provide an alignment of the *NGSS High School Life Science Standards* (NGSS Lead States, 2013) and the *NGSS High School Engineering, Technology, and the Applications of Science Standards* (NGSS Lead States, 2013) to the *National Standards for Family and Consumer Sciences* (NASAFACS, 2008-2018) and included Suggested Integrated Learning Activities. Similarly, Carter et al. (2019) provided an alignment of the *National Standards for Family and Consumer Sciences* (NASAFACS, 2008-2018) and the *Common Core State Standards for Mathematics* (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010) and provided Suggested Integrated Learning Activities.

High-quality FCS programs provide rigorous and relevant classroom instruction aligned with high demand workforce skills, while engaging students in work-based learning experiences, embedding national programs and competitive events of FCCLA, and facilitating industry-recognized credentials and post-secondary credits (LEADFCS, n.d.). FCS teachers teach employability skills such as interpersonal skills, communication skills, personal qualities, and resource management (LEADFCS, n.d.). Courses also develop critical thinking, systems thinking, applied academic skills, resource management, information and technology use, personal qualities, and interpersonal and communication skills (Nickols, 2009).

According to the United States Department of Education (2020), 7.6 million secondary students earned credits in CTE during the 2019-2020 school year. The National Center for Education Statistics (2013) found that 92% of high school students earn credits in CTE and 37% of high school students earn credits in FCS. Aligning CTE, including FCS, and STEM, may increase the interest of underrepresented populations in STEM disciplines (Carter et al., 2015). Of the five million students taking FCS courses (AAFCS, n.d.), 65% are female (Carter et al., 2015). FCS could provide a pathway for more female students to enter STEM fields (Carter et al., 2015). FCS educators may draw the interest of minority students to STEM by focusing on STEM concepts within the FCS curriculum and by working with colleagues to design effective curriculum (Carter et al., 2015). According to Deaton et al. (2018), increasing highly effective integrated STEM content within FCS may improve schools' overall academic performance.

The Family, Career and Community Leaders of America (FCCLA) serves as the Career and Technical Student Organization (CTSO) for middle and high school students who have completed or are enrolled in at least one FCS course (FCCLA, n.d.). FCCLA provides students with opportunities to develop and apply the skills learned in the FCS classroom and emphasizes exploring various careers, analyzing and solving problems met in daily life, expanding leadership skills beyond the classroom, and building relationships between students, families, schools, and communities (Garrison, 2007). Garrison (2007) suggested that FCCLA members experience personal growth, enhanced academic achievement, and enhanced career awareness and employability skills. Results also suggested that participation in chapter projects, events, and leadership opportunities fosters more engaging, rigorous, and authentic learning opportunities while developing personal relationships and opportunities to experience success (Garrison, 2007). All sixteen of the Areas of Study included in the *National Standards for Family and Consumer Sciences Education* (National Association of State Administrators of Family and Consumer Sciences [NASAFACS], 2008-2018) are aligned to FCCLA activities and programs, showing how FCCLA provides students with opportunities to apply and develop the skills learned in the classroom. FCCLA provides opportunities for students to develop leadership and employability skills in the areas of Hospitality and Tourism, Visual Arts and Design, Education and Training, and Human Services while also exploring the interrelationships between family, community, and work (FCCLA, n.d.). FCCLA and many FCS classrooms use the FCCLA Planning Process (FCCLA, n.d.). This Planning Process has clear connections to the *Next Generation Science Standards* (Carter et al., 2015). Both acknowledge the importance of 21st century skills and both require students to solve problems, think critically, and develop the necessary tools for approaching a problem (Carter et al., 2015). Both guide students toward an inquiry-based approach to learning (Carter et al., 2015). Carter et al. (2015) compared the FCCLA Planning Process and the *Next Generation Science Standards* (NGSS Lead States, 2013) to show how closely the two are aligned.

Merrill (2016) found that that most FCS teachers felt competent to teach new standards related to STEM within their foods curriculum but were seldom given appropriate professional development to do so in areas they did not feel competent to teach. Typically, science integration was viewed as important to teach, and teachers were fairly confident in their ability to integrate it. Engineering was usually the area of least confidence for teachers, followed by integration of technology. The FCS teachers in the study were willing and enthusiastic about integrating more STEM into the teaching of foods. They desired support with new lesson plans, labs, and easily accessible resources. Teachers were interested in more summer conferences, e-newletters with resources, webinars, study groups, or a combination of these items (Merrill, 2016).

Merrill and Lawver (2019) conducted a needs assessment to identify the gap between teacher-perceived levels of importance and teacher-perceived competence for each objective in the revised Food and Nutrition Sciences curriculum. This curriculum was implemented in Utah within FCS programs starting in 2014 to strengthen STEM-related content. Although teachers felt moderately competent to teach the new curriculum, results indicated the most need for professional development in Standard 1: Kitchen Safety Procedures and Sanitation, which includes food handling safety rules and guidelines, first aid, food handler health and hygiene, sanitation guidelines, and the identification and prevention of food-borne illnesses and contamination (Merrill & Lawver, 2019). This information is vital for a safe food environment in the classroom and for students to use at home or in the workplace. Findings support the need for increased professional development training in STEM-related fields to strengthen the FCS teachers' ability to teach STEM concepts in class, leading to a higher level of self-efficacy (Merrill & Lawver, 2019).

Ogle et al. (2017) implemented a STEM enrichment curriculum, Fashion FUNdamentals (FF), for middle school girls, and their findings suggest FF had positive influences on middle school girls' self-efficacy in math and science and their knowledge in math. At the conclusion of the program, girls' self-efficacy in math and science positively predicted their interest in STEM. Focus group data revealed some girls learned to appreciate new science applications which may foster future interest and achievement in STEM disciplines (Ogle et al., 2017). Etheredge et al. (2014) advocated for STEM integration in textile design and interior design courses but explained that ergonomics, sustainable practices, acoustics, thermal systems, material estimations, and lighting calculations are STEM applications easily incorporated into innovative, project-based learning in interior design. Such projects exposed students who might have steered away from traditional STEM courses toward applied science, technology, engineering, and mathematics and related STEM careers (Etheredge et al., 2014).

## STEM Integration in CTE

Similar results have been identified within other areas of CTE. Smith et al. (2015) found that agriculture teachers recognize the importance of integrating STEM concepts in their curriculum and see STEM integration as a critical component of agricultural educators. They also found that female agriculture teachers perceived technology integration as less important than their male colleagues and felt less capable when teaching engineering concepts (Smith et al., 2015). This study found that the confidence ratings of ability to integrate STEM concepts varied by content area. Consequently, researchers recommended examining teacher content knowledge related to all four STEM concepts separately (Smith et al., 2015).

Wu-Rorrer (2017) indicated that strategies for STEM education within CTE are not clearly defined. This study sought to fill the gap of current research in middle school CTE and STEM programs by determining how local, state, and national educators, administrators, directors, specialists, and curriculum writers could effectively integrate STEM programs into middle school CTE programs by (Wu-Rorrer, 2017). They outlined a successful example of STEM integration in middle school programs that made real-world connections between the theories learned in STEM courses and the hands-on applications within engineering and technology courses. Wu-Rorrer (2017) concluded STEM integration in CTE must link academic knowledge and skills directly with authentic applications.

## Social Cognitive Theory and Self-efficacy

Bandura's social cognitive theory emphasizes the cognitive and environmental factors that impact behavior, including the external and internal aspects of social reinforcement (Bandura, 1991). This includes the influence an individual's past experiences have on their future path. Self-efficacy is at the core of social cognitive theory (Bandura, 1997). Self-efficacy is an individual's belief that they can successfully control actions or events in their lives, based on the feeling that they possess the cognitive abilities, motivation, and resources required to complete the task (Bandura, 1997). Bandura suggested that a person's level of self-efficacy is significant in determining whether they will attempt a given task (Bandura, 1997). If self-efficacy is high, the individual is more likely to attempt a task because they view the challenge as attainable. They attribute failures to insufficient effort (Bandura, 1991). However, if self-efficacy is low, they will be less likely to attempt a task (Bandura, 1977, 1986). They are likely to view failures because of low ability (Bandura, 1991). Bandura believed that self-efficacy influenced an individual's choices, aspirations, the effort they put into a task, how long they persevered in difficult situations, whether their thought patterns would help or hinder them, the amount of stress caused by their environment, and their vulnerability for depression (Bandura, 1991). People display lasting interest in activities in which they feel self-efficacious and satisfied (Bandura, 1991).

Self-efficacy emphasizes the importance of the individual and the individual's perceptions of his/her ability (Bandura, 1991). However, high confidence does not always equate to high ability (Bandura, 1997). In addition, Bandura (1977) also felt that four key characteristics: performance accomplishments, vicarious experience, verbal persuasion, and emotional arousal, directly influenced that self-efficacy.

**Performance Accomplishments**

The self-efficacy theory identifies that performance accomplishments are based on personal mastery experiences (Bandura, 1977). Success raises mastery expectations while failures lower them. Bandura (1977) stated that this could be quite problematic if the failure occurs in the early stages of a particular event. Repeated success develops strong efficacy expectations and reduces the negative impact of occasional failures (Bandura, 1977). Self-motivated persistence can improve as individuals overcome occasional failures. Modeling can help individuals gain a skill for successfully dealing with stressful situations. Such coping skills can contribute to improved self-efficacy (Bandura, 1977).

**Vicarious Experience**

Through modeling, vicarious experiences allow an individual to observe others performing an arduous task or behavior without adverse consequences (Bandura, 1977). This can generate an expectation in observers that they too will improve if they persist in their efforts. Observing success is essential, especially in hard actions, for the individual to gain the confidence to attempt that task or behavior (Bandura, 1977).

**Verbal Persuasion**

Verbal persuasion is a component of self-efficacy that uses suggestion to lead people to believe they can successfully accomplish a task or behavior that had overwhelmed them (Bandura, 1977). Research suggests limitations for efficacy developed through verbal persuasion, such as the individual's expectations exceed what they can actually accomplish (Bandura, 1977).

**Emotional Arousal**

Emotional arousal allows an individual to recognize negative feelings, such as fear, stress, and physical agitation, as barriers to completing a specific behavior or task (Bandura, 1977). When an individual can identify stressors, they can develop and implement appropriate coping skills to accomplish the task. Bandura suggests modeling behaviors to ease these negative feelings and thus improve self-efficacy to complete a behavior or task (Bandura, 1977).

## Teacher Self-Efficacy

Bandura's self-efficacy theory can be applied to the teaching profession, though the first studies of teacher efficacy were conducted by the RAND organization and were grounded in Rotter's social learning theory (Tschannen-Moran et al., 1998). Tschannen-Moran et al. (1998) defined teacher efficacy as a teacher's belief in their own capability to develop the course of action to accomplish a specific teaching task related to specific subject matter. Tschannen-Moran and McMaster (2009) added that teacher self-efficacy includes teachers' perceived capability to share knowledge and to influence student behavior. Components of teacher self-efficacy included willingness to be open to new ideas, the ability to take risks, having effective planning and organizational skills, and displaying an overall enthusiasm and commitment to teaching (Tschannen-Moran et al., 1998).

Smith et al. (2015) postulated that teachers who perceived that they could effectively teach a concept would likely be successful in teaching that concept to students. The results of Zee and Koomen's (2016) review of 165 articles suggested positive correlations between teacher self-efficacy and students' academic achievement. Additional evidence on the relationship between teachers' self-efficacy for teaching and students' achievement, motivation, and own sense of self-efficacy exists (Corkett et al.; 2011, Mahmoee & Pirkamali, 2013; Mojavezi & Tamiz, 2012; Quackenbush, 2020). Tschannen-Moran et al. (1998) found similar results and stated that beyond student achievement, teacher efficacy shapes students' attitudes toward school, their attitude toward the subject matter, and their attitude toward the teacher.

Teacher efficacy has been defined as both context and subject-matter specific (Tschannen-Moran et al., 1998), and research indicated that teachers with limited knowledge in a subject outside of their area of expertise struggle to have confidence in teaching those subjects (Stohlmann et al., 2012). Hence, a teacher may feel very competent teaching one subject or feel more capable of teaching a certain group of students and less so in another subject or with other students (Tschannen-Moran et al., 1998). Because FCS teachers are required to know a variety of disciplines and to teach a variety of courses, it is important to know the confidence level that an FCS teacher has in their ability to successfully teach a particular course. Research on teachers' self-efficacy investigated the factors related to the improvement of teaching efficacy; however, few studies have concentrated on factors that may predict teachers' self-efficacy as it relates to teaching STEM concepts. Smith et al. (2015) evaluated gender, age, type of certification, length of teaching career, and perceptions of integrating STEM components as the factors in their study. They determined teachers perceived each of the four components of STEM integration as important, and teachers had high levels of confidence integrating science and mathematics but reported lower confidence levels for technology and engineering. They identified differences between gender and confidence integrating engineering, as well as gender and perceptions of instructional method effectiveness (Smith et al., 2015).

Knowing an FCS teacher's confidence level as they integrate STEM concepts is also important. Liceaga et al. (2014) found that many FCS teachers were "hesitant about teaching and implementing food science concepts in their classes simply because they were intimidated by the material and were not confident in their ability to teach it" (p. 28). The same study found that

FCS teachers were not very familiar with food science and felt that they could not "effectively integrate it into the curriculum without some form of guidance" (Liceaga et al., 2014, p. 28), but they stated an interest to teach food science concepts if they were provided with age-appropriate instructional strategies (Liceaga et al., 2014). Factors specific to FCS teachers' self-efficacy when teaching STEM are lacking in the literature, therefore, a gap exists.

## Summary

Chapter II provided a review of the literature on STEM education, including integrated STEM recommendations, to determine what relevant research has been performed. Social cognitive theory and teacher self-efficacy were explored to see what factors impact FCS teachers' self-efficacy regarding STEM concepts. It also reviewed the foundations of career and technical education, the role of integrated STEM, and the connection between family and consumer sciences and integrated STEM education. Chapter III will address the methods and procedures used to conduct this study. Chapter IV will present the findings of this study. Chapter V will summarize the results of the research, draw conclusions to the findings, and list recommendations based on these conclusions.

# Chapter III

# METHODOLOGY

The purpose of this study was to identify factors that may affect family and consumer sciences teachers' level of self-efficacy in teaching STEM education to provide supports that improve teaching practices. Several factors were evaluated in this study to determine how comfortable family and consumer sciences teachers feel providing instruction in STEM. Factors taken into consideration included years of teaching experience, instruction received in teacher preparation programs, years of teaching experience, participation in professional development, and involvement in extracurricular activities. This study set out to determine the needs of family and consumer sciences teachers so that they can be successful and more confident when integrating STEM into FCS courses.

## Research Design

A descriptive research design was used to examine FCS teachers' self-efficacy beliefs about implementing integrated STEM education. A descriptive research design is intended to make sense of a situation as it currently exists in the world and involves no manipulation or control of a treatment or conditions (Leedy et al., 2019). This study employed a quantitative research design which Leedy et al. (2019) defines as a common method when describing current conditions, investigating relations, and trying to predict an outcome. This study used a post-positivist perspective to demonstrate a single, objective reality (Leedy et al., 2019). Self-efficacy is specific to a particular goal or domain and is measured by asking respondents to rate their confidence in achieving a particular goal (Nadelson et al., 2012). When measuring the construct of teaching self-efficacy, it is recommended that a context-specific instrument is used to determine a respondent's belief in their ability to teach a specific aspect of science, mathematics, engineering, and technology (Nadelson et al., 2012). Consequently, the *T-STEM Survey for Elementary Teachers* was requested from the Friday Institute for Educational Innovation (2012) and converted to an online format.

The *T-STEM* has been used to collect data for similar research by Srikoom and Faikhamata (2018) who developed and administered the Initial STEM survey (ISTEM survey) in Thailand to in-service teachers (*n* = 275) of science, mathematics, and technology, to identify teachers' self-efficacy for teaching STEM, their beliefs about STEM, and the challenges and needs about teaching STEM education. Their findings indicated that the teachers' gender and experience influenced their self-efficacy, beliefs, and attitude about STEM education (Srikoom and Faikhamata, 2018).

## Instruments

There are several distinct advantages to using surveys to collect data. They are relatively inexpensive, can be distributed to many people in faraway locations, require a short administration time, and may provide anonymity (Leedy et al., 2019). Survey research determines the "incidence, frequency, and distribution of certain characteristics in a population" (Leedy et al., 2019, p. 93). Therefore, to appropriately address the quantitative research questions, a search for survey questions was undertaken. Measurements of teacher efficacy are recent, so few tools exist to quantify them in a valid and reliable way, especially when specifically targeting teacher efficacy in STEM subjects. Even though it has not been used with secondary teachers, the *Teacher Efficacy and Attitudes Toward STEM* (*T-STEM*) *Survey*, created by the Friday Institute for Educational Innovation (2012) at North Carolina State University, was an ideal option for this study. Five versions of the *T-STEM Survey* have been developed, one for each teaching area of STEM and one for elementary teachers. Partially funded by the National

Science Foundation and by the Golden LEAF foundation, the *T-STEM* Surveys were developed in the spring of 2011 as part of the Maximizing the Impact of STEM Outreach education evaluation project. Each of the *T-STEM* Surveys was designed to measure teachers' self-efficacy for teaching and their beliefs that teachers affect student learning, the frequency of student technology use, teachers' instructional practices related to STEM, teachers' attitudes toward 21st-century learning and teacher leadership, as well as STEM career awareness. Responses are collected and analyzed at the scale- and item-level (Friday Institute for Educational Innovation, 2012).

The *T-STEM Survey for Elementary Teachers* instrument contains nine constructs: Personal STEM Teaching Efficacy and Beliefs (PSTEB); STEM Teaching Outcome Expectancy Beliefs (TOEB), both of which include separate questions for science and mathematics; Student Technology Use; STEM Instruction; 21st Century Learning Attitudes; Teacher Leadership Attitudes; and STEM Career Awareness. The *T-STEM Survey for Elementary Teachers* is not designed specifically for elementary teachers, but rather it addresses one teacher who would teach multiple subject areas, as elementary teachers typically do. Other *T-STEM* Surveys were designed for teachers who teach a single subject area, such as math, science, or technology education. The *T-STEM Survey for Elementary Teachers* combines these other surveys into one. Because FCS teachers integrate various STEM subjects into their curriculum, the *T-STEM Survey for Elementary Teachers* was selected. Results identify participant attitudes and the frequencies with which STEM activities are taking place, and the survey is available to help program coordinators decide on improvements to their program (Friday Institute for Educational Innovation, 2012). The Friday Institute for Educational Innovation granted permission to use the survey (Appendix B).

The first scale, within the *T-STEM Survey for Elementary Teachers*, Personal STEM Teaching Efficacy Belief (PSTEB), comprises questions about teachers' confidence in their teaching skills. The second scale, the STEM Teaching Outcome Expectancy Beliefs (TOEB), covers questions about the degree to which teachers believe they can affect students' learning with effective teaching. These two constructs were derived from the *Mathematics Teaching Efficacy Belief Instrument* (Enoch et al., 2000); (MTEBI) and the *Science Teaching Efficacy Belief Instrument* (STEBI); (Riggs & Enoch, 1990). The STEBI has been the dominant measurement tool of in-service science teacher self-efficacy and outcome expectancy for nearly 30 years (Riggs & Enoch, 1990). The MTEBI was derived from the STEBI (Enoch et al., 2000). Due in part to concerns about aspects of the STEBI, including the wording, validity, reliability, and dimensionality, the *T-STEM* Science Scale was developed (Unfried et al., 2022).

The third scale addresses the frequency that students use technology. This construct was developed from the Student Technology Needs Assessment, or STNA (SERVE Center, 2005) and was modified by the Friday Institute with permission of SERVE. The fourth scale addresses the frequency of STEM instructional practices and was based on items developed by the Friday Institute. The fifth scale asks teachers about their perceptions of 21st century learning and was adapted from the Friday Institute's Student Learning Conditions Survey (2011). The final scale items in the survey ask teachers about their attitudes toward teacher leadership and their awareness of STEM careers. These items were taken from the North Carolina Department of Public Instruction's professional standards for educators.

Prentiss Bennett (2016) asserted that many educators are not clear about what STEM education and integrated STEM are, because the acronym is used so frequently and recommended providing participants with a definition for these terms. Consequently, this study presented participants with a definition of STEM education and integrated STEM education to offer some clarity before taking the survey. According to the Friday Institute for Educational Innovation (2012), permission is granted to use the instrument in its entirety or modified based on the needs of the researcher. Respondents were asked to complete seven scales from the *T-STEM Survey for Elementary Teachers*: Teaching Efficacy and Beliefs Scale (science and mathematics), Teaching Outcome Expectancy Scale (science and mathematics), Student Technology Use, STEM Instruction, and 21st Century Learning Attitudes. The Teaching Efficacy and Beliefs Scale for science and mathematics measures the construct of personal teaching and efficacy beliefs. The Teaching Outcome Expectancy Scale for science and mathematics measures the construct of teaching outcome expectancy beliefs. These two scales were chosen to measure participants' self-efficacy and confidence related to teaching specific STEM subjects and their general beliefs that student learning in specific STEM subjects can be impacted by actions of teachers. Student Technology Use, STEM Instruction, and 21st Century Learning Attitudes are also central concepts to integrated STEM as it is described in this study, therefore, these constructs were included in the survey. The survey included 68 questions.

The *T-STEM Survey for Elementary Teachers* was converted into an electronic version using Google Forms. The survey uses a Likert scale, and the instructions recommend assigning the value of "1" every time a teacher responds, "strongly disagree;" "2" for "disagree;" "3" for "neither agree nor disagree;" "4" for "agree;" and "5" for "strongly agree." Most of the survey questions are positively worded. However, a few are negatively worded and would be assigned values in reverse order. The numbers in each section are averaged to calculate the score. The Friday Institute for Educational Innovation recommends using this survey to help program coordinators decide on improvements to their programs. As such, this information will be used to recommend supports to increase STEM teaching self-efficacy for FCS teachers.

The link to the form was sent out by email (Appendix D) through the Family, Career and Community Leaders of America (FCCLA) coordinator for Pennsylvania, through the Pennsylvania Association of Family and Consumer Sciences listserv, and through the Pennsylvania Department of Education’s Family and Consumer Sciences coordinator’s listserv. The informed consent form was included in the survey (Appendix E). Results from this study were examined to ensure participants were certified FCS teachers. This information was self-reported in the survey. Responses were examined for incomplete and invalid surveys.

**Validity and reliability**

The validity and reliability of an instrument influence what can be learned from the data, the statistical significance of the analyses, and the conclusions that can be made (Leedy et al., 2019). Validity is concerned with the accurate assessment of the characteristics or phenomena in question, whereas reliability is the degree to which an assessment strategy yields consistent, stable results (Leedy et al., 2019). Internal consistency reliability measures the extent to which an individual’s scores across items or tasks within a single assessment instrument yield similar results. Cronbach’s alpha coefficient is best suited for multinumber rating scales (Leedy et al., 2019). Expressed as a number between 0 and 1, Cronbach’s Alpha assesses the degree of internal consistency of an instrument. The closer to 1, the better the internal consistency of the survey items.

To determine the validity and reliability of the *T-STEM Survey*, researchers at the Friday Institute for Educational Innovation (2012) pilot tested and evaluated for reliability and validity (Friday Institute for Educational Innovation, 2012). Surveys were administered to 257 science teachers, 72 technology teachers, 17 engineering teachers, 120 mathematics teachers, and 218 elementary teachers. Explanatory factor analysis was used to allow factors to be correlated, with item loadings above .40 classified as significant. Ratings from subject matter experts, and written feedback from the survey participants were assessed and compared for common items across different surveys. The PTEB scale comprised 11 items for science and mathematics ($\alpha = .91$, $\alpha = .94$, respectively), the TOEB scale comprised nine items for science and mathematics ($\alpha = .85$, $\alpha = .90$, respectively), Student Technology Use consisted of eight items ($\alpha = .87$), STEM instruction comprised 14 items ($\alpha = .93$), and the 21st Century Learning Attitudes comprised 11 items ($\alpha = .95$). The survey has been validated at the construct-level, not at the item-level; therefore, it is recommended that comparisons be made at the construct-level (Friday Institute for Educational Innovation, 2012). For this reason, constructs were measured with separate regression models and no overall self-efficacy score was assigned. The construct reliability levels measured with Cronbach's Alpha are presented in Table 2.

**Table 2**

*Reliability of the T-STEM Surveys*

| Construct | Number of Items | Cronbach's Alpha | | | | |
|---|---|---|---|---|---|---|
| | | Science (*n = 154*) | Technology (*n = 59*) | Engineering (*n = 9*) | Math (*n = 102*) | Elementary (n = *228*) |
| Personal Teaching Efficacy and Beliefs | 11 | .908 | N/A | N/A | .943 | .905 (Sci)<br>.939 (Math) |
| Teaching Outcome Expectancy Beliefs | 9 | .814 | N/A | N/A | .849 | .854 (Sci)<br>.895 (Math) |
| Student Technology Use | 8 | .900 | N/A | N/A | .869 | .943 |
| STEM Instruction | 14 | .934 | N/A | N/A | .929 | .95 |
| 21st Century Learning Attitudes | 6 | .948 | .948 | .948 | .948 | .948 |

Friday Institute for Educational Innovation (2012)

## Participants

A purposive sample was used for this study. This type of sampling does not involve the use of randomization but rather selects participants for a particular purpose and who are easily available to the researcher (Leedy et al., 2019). The population for the sample is family and consumer sciences teachers in Pennsylvania. Middle and high school family and consumer sciences teachers will compose the study participants. In a national survey of FCS teachers, Werhan (2013) reported that there were 1,712 secondary FCS teachers in Pennsylvania; however, according to K. Helm, Chief of Certification Services for the Pennsylvania Department of Education, there were 954 people holding an FCS certification as of 2018 and another 401 people teaching FCS without a certification (K. Helm, personal communication, October 5, 2021). Only those with an Instructional Level I or Instructional Level II certification in Family and Consumer Sciences will be considered for the study. According to the Pennsylvania Department of Education (n.d.), to obtain a Level I certification in Pennsylvania, the individual must successfully complete a Pennsylvania Department of Education (PDE) approved teaching program and get the required scores on the Praxis exams for basic mathematics and reading skills, general knowledge, professional knowledge, and subject area knowledge. To move from Level I to Level II certification, the applicant must complete 24 credits in a state approved program, participate in a state-approved induction and mentoring program, and receive six semi-annual satisfactory evaluations by their employer within six years of receiving their Level I certification (Pennsylvania Department of Education, n.d.). FCS certification in Pennsylvania is for grade levels pre-K through 12, and these grade levels are also included in the Pennsylvania state standards for FCS. That means that FCS teachers are required to teach a wide variety of ages and topics in their courses.

This sample will be solicited to complete the survey via email. The email will be sent out through the state's FCCLA facilitator, the FCS content advisor for PDE, and through the Pennsylvania Association of FCS. An incentive of two randomly selected gift cards was offered to participants. The sample was selected because they represent a range of ages, experience, locations, school types, degree levels, and genders needed to answer the research questions. G*Power (Faul, Erdfelder, Lang, & Buchner, 2007, 2009) is a free, stand-alone power analysis program for many statistical tests commonly used in the social, behavioral, and biomedical sciences. A priori power analysis was conducted using G*Power for a linear regression with five predictors, a small effect size ($d$ = .15), and an alpha of .05. Per sample size calculations provided by G*Power, a sample size of 74 would be representative of the given population.

## Variables

Research variables were aligned with the research questions. The dependent variable, STEM teaching self-efficacy, was broken into seven separate dependent variables based on the recommendation of the Friday Institute for Educational Innovation to keep the constructs separate (Friday Institute for Educational Innovation, 2012). Seven scales in the *T-STEM Survey for Elementary Teachers* will be assessed in this study and include science teaching efficacy and beliefs, science teaching outcome expectancy, mathematics teaching efficacy and beliefs, mathematics teaching outcome expectancy, student technology use, STEM instruction, and 21st century learning attitudes.

The first independent variable was participation in FCCLA. This is a categorical variable. Participants were asked whether they participated in FCCLA. The second independent variable was the number of STEM courses taken by the FCS teacher. Participants were asked to self-report the number of STEM courses they have taken throughout their undergraduate and graduate coursework. STEM courses include courses taken in science, technology, engineering, mathematics, and family and consumer sciences. This was a continuous variable. The third independent variable was the highest educational level of the FCS teacher. The options were bachelors, masters, and doctoral degrees. We can order these variables from lowest to highest, but the spacing between the values may not be the same across the levels of the variables, therefore it is an ordinal variable. The fourth independent variable was years of teaching experience, including the present year. This was a continuous variable. Participants were asked to self-report their years of teaching. The fifth independent variable was gender. This was a categorical variable. To be inclusive and to limit errors and ridiculing responses, Broussard et al. (2018) urges a multiple-choice option. Participants in this study could select one of the following options for this variable: male, female, non-binary, decline to answer. These variables will be assessed to determine if they affect STEM teaching self-efficacy levels for FCS teachers. These factors were selected after reviewing the existing literature.

## Procedures

Before the distribution of the instrument, this study was submitted to the Institutional Review Board at Old Dominion University. This study was classified as having minimal risks to participants because it is survey research involving consenting adults. Initiation of the study and collection of data via the online survey will begin once approval is given (Appendix A). Participant data will remain confidential; however, consent forms will be obtained prior to participation and maintained on a password protected computer.

This self-report survey will be distributed via e-mail to middle and high school FCS teachers in Pennsylvania who teach FCS during the 2021-2022 academic year. Correspondence regarding this survey will include the following information:

1. The purpose of the study

2. An invitation to participate in the study detailing anonymity, minimal risks, voluntary participation, and contribution to the family and consumer sciences profession

3. A definition of integrated STEM education

4. A link to the consent form.

Participants who do not consent exit the survey. Those who consent continue to the survey. The complete protocol provided to participants is found in Appendix E. To maintain the integrity of the results, participants will only be permitted to submit the survey once. Names will be collected to help ensure that there are no duplicates. If participants complete the online survey, their identity will be kept confidential, and they can stop at any time. Participants will be asked to set aside a block of 10-20 minutes to complete the survey. To promote a high participation response, data will be collected from April to May. The following timeline is a description of how the online survey was distributed to reach participants:

1. Middle of April: A description, invitation, and link to the survey will be sent out via email through Pennsylvania's FCCLA facilitator, the FCS content advisor for the Pennsylvania Department of Education, and through the Pennsylvania Association of FCS (PAFCS) to their respective listservs.

2. End of April: After 2 weeks, a reminder to complete the survey will be sent out through the same channels. A reminder will be posted on the PAFCS website bulletin board and newsletter, as well as on their social media accounts.

3. Beginning of May: After 1 week, a final reminder to complete the survey will be sent out.

## Data Analysis

Data analysis for this quantitative study incorporated the use of Statistical Package for the Social Sciences (SPSS) 27 to analyze survey responses. Descriptive and inferential statistics were used to interpret results that were submitted by participants. Similar studies by Srikoom and Faikhamata (2018) and Prentiss Bennett (2016) conducted descriptive analysis including frequency, mean, and standard deviation to display overall participant demographic information, challenges and needs of teaching STEM. This method would be effective in this study. This also follows the recommendation of the Friday Institute for Educational Innovation (2012). This study asks the two following research questions:

1. What is the level of self-efficacy of FCS teachers regarding teaching STEM concepts?
    a. What is the level of FCS teachers' science teaching efficacy and beliefs?
    b. What is the level of FCS teachers' science teaching outcome expectancy?
    c. What is the level of FCS teachers' mathematics teaching efficacy and beliefs?
    d. What is the level of FCS teachers' mathematics teaching outcome expectancy?
    e. What is the level of FCS teachers' perceptions of student technology use?
    f. What is the level of FCS teachers' STEM instruction?
    g. What is the level of FCS teachers' 21st century learning attitudes?
2. How will each of the teacher demographic variables (i.e., participation in FCCLA, number of STEM courses taken, education level, number of years teaching, and gender) respectively predict the level of self-efficacy of FCS teachers when teaching STEM concepts?
    a. How will each teacher demographic variable predict FCS teachers' science teaching efficacy and beliefs?

b. How will each teacher demographic variable predict FCS teachers' science teaching outcome expectancy?

c. How will each teacher demographic variable predict FCS teachers' mathematics teaching efficacy and beliefs?

d. How will each teacher demographic variable predict FCS teachers' mathematics teaching outcome expectancy?

e. How will each teacher demographic variable predict FCS teachers' perceptions of student technology use?

f. How will each teacher demographic variable predict FCS teachers' STEM instruction?

g. How will each teacher demographic variable predict FCS teachers' 21st century learning attitudes?

To answer these questions, descriptive statistics were analyzed to provide a basic understanding of the participants of the study based on specific characteristics and how they performed on a particular outcome (Leedy et al., 2019). The Friday Institute cautions that strong conclusions about a teacher's attitude should not be made from their responses to a single question. The surveys have been validated at the construct-level, not at the item-level; therefore, it is recommended that comparisons be made at the construct-level. This instrument has not been validated as a tool to obtain a single, cumulative self-efficacy score. To answer the first research question and to get the most thorough measure of teacher attitudes, the Friday Institute for Educational Innovation (2012) recommends summarizing together the questions in all seven sections. For example, to get a thorough understanding of a teacher's "Teaching Outcome Expectancy Beliefs" their responses to all nine questions from the section "Teaching Outcome

Expectancy Beliefs" should be averaged (Friday Institute for Educational Innovation, 2012). Assign the value of "1" every time a teacher responds "strongly disagree," "2" for "disagree," "3" for "neither agree nor disagree," "4" for "agree," and "5" for "strongly agree" (Friday Institute for Educational Innovation, 2012). Then, those numbers are averaged together for all the teachers' responses in the section to get a "score" for that teacher for their "Teaching Outcome Expectancy Beliefs". A higher score means the teacher believes teacher actions affect student learning (Friday Institute for Educational Innovation, 2012). All teachers' scores can be averaged together to get a score for, say, the school or the state. The Friday Institute for Educational Innovation (2012) recommends analyzing mean, range, frequency counts, percentages, median, and mode.

To answer the second research question, a regression analysis was used to test the differences among variables that had significant effects (significance level at $p < 0.05$). This is also consistent with the study by Srikoom and Faikhamata (2018). Simple linear regression was selected for use in this study for its ability to accommodate both categorical and continuous variables (Keith, 2015). Simultaneous regression was used for its value in explanatory research to determine the influence of multiple variables on the outcome (Keith, 2015). The researcher performed a regression analysis with each of the teacher self-efficacy construct scores as the dependent variable and participation in FCCLA, number of STEM courses taken, education level, number of years teaching, and gender as the independent variables.

The $R^2$ as the effect size index will be computed to quantify the strength of the relationships between the various predictor variables and the dependent variable (Keith, 2015). The level of significance was set at .05 level, as that is the customary level used when working on significance (Keith, 2015). The *F* test was used to test the statistical significance of the predictor in a regression equation (Keith, 2015).

**Summary**

The purpose of this study was to determine what factors impact FCS teachers' level of self-efficacy in teaching STEM education to provide supports for improving teaching practices. In this quantitative study, the *T-STEM Survey for Elementary Teachers* was used to survey middle and high school FCS teachers in Pennsylvania. To the knowledge of this researcher, this is the first study of its kind that focused on how comfortable FCS teachers feel about teaching STEM concepts. This study consists of two major research questions. The first research question focused on the level of self-efficacy of FCS teachers regarding teaching STEM concepts. The second evaluated how self-efficacy levels may be affected by the factors of demographic information, STEM coursework, type of certification, education level, extracurricular activities, and years of experience were assessed to determine if they affect STEM teaching self-efficacy levels for FCS teachers.

The survey collects information on teachers' self-efficacy for teaching, belief that teachers affect student learning, frequency of technology use, frequency of using certain STEM instructional practices, attitudes toward 21st century learning, attitudes toward teacher leadership, and awareness of STEM careers. Results were analyzed using descriptive statistics and linear regression analysis.

STEM education is important for our national workforce. Upon review, no research could be found to help improve the quality of STEM education within FCS courses. The information in this study could help to shape college coursework for pre-service teachers and in-service opportunities for existing teachers. This can be done by determining how confident FCS teachers feel in their ability to teach STEM concepts and the factors that impact their level of self-efficacy.

# Chapter IV

## RESULTS

The problem of this study was to identify factors that may be related to family and consumer sciences teachers' self-efficacy in teaching STEM education to provide supports that improve teaching practices. This chapter presents results by the research questions (variable abbreviations in parentheses):

1. What is the level of self-efficacy of FCS teachers regarding teaching STEM concepts?
    a. What is the level of FCS teachers' science teaching efficacy and beliefs? (SCIEFF)
    b. What is the level of FCS teachers' science teaching outcome expectancy? (SCIOUT)
    c. What is the level of FCS teachers' mathematics teaching efficacy and beliefs? (MATHEFF)
    d. What is the level of FCS teachers' mathematics teaching outcome expectancy? (MATHOUT)
    e. What is the level of FCS teachers' perceptions of student technology use? (TECHUSE)
    f. What is the level of FCS teachers' STEM instruction? (STEMINST)
    g. What is the level of FCS teachers' 21st century learning attitudes? (TWELEAR)
2. How will each of the teacher demographic variables (i.e., participation in FCCLA, number of STEM courses taken, education level, number of years teaching, and gender) respectively predict the level of self-efficacy of FCS teachers when teaching STEM concepts?

a. How will each teacher demographic variable predict FCS teachers' science teaching efficacy and beliefs? (SCIEFF)

b. How will each teacher demographic variable predict FCS teachers' science teaching outcome expectancy? (SCIOUT)

c. How will each teacher demographic variable predict FCS teachers' mathematics teaching efficacy and beliefs? (MATHEFF)

d. How will each teacher demographic variable predict FCS teachers' mathematics teaching outcome expectancy? (MATHOUT)

e. How will each teacher demographic variable predict FCS teachers' perceptions of student technology use? (TECHUSE)

f. How will each teacher demographic variable predict FCS teachers' STEM instruction? (STEMINST)

g. How will each teacher demographic variable predict FCS teachers' 21st century learning attitudes? (TWELEAR)

The findings of this study are presented in this chapter, including response rate, descriptive data, and regression analysis. A list of the coding variables utilized in the study can be found in Appendix F.

**Response Rate**

There were 79 responses to the *Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey.* After screening to ensure that all participants were FCS certified teachers, two responses were excluded from the study. This left a useable sample of 77. As sample size is a function of the number of predictors, the size of the effect, and desired power, G*Power was used to calculate the sample size for this study (UCLA Statistical Consulting Group, 2021). A priori power analysis was conducted using G*Power for a linear regression with five predictors, a small effect size (*d* = .15), and an alpha of .05. The sample size computes to 74; 77 exceeds this recommended sample size, thereby validating the sample.

**Descriptive Data**

Of the participants (*n* = 77), 77 were females (100%) and 0 were males (0%). The range of years in teaching ranged from one to 42 with a mean of 16.84 years (*Mdn* = 15, IQR: 10, 22). Thirteen participants had a bachelor's degree (16.9%), 63 had a master's degree (81.8%), and one had a doctoral degree (1.3%). Nine participants (11.7%) held their Level I teaching certification and 68 (88.3%) held their Level II teaching certification. To obtain a Level I certification in Pennsylvania, the individual must successfully complete a Pennsylvania Department of Education (PDE) approved teaching program and get the required scores on the Praxis exams for basic mathematics and reading skills, general knowledge, professional knowledge, and subject area knowledge (Pennsylvania Department of Education, n.d). To move from Level I to Level II certification, the applicant must complete 24 credits in a state approved program, participate in a state-approved induction and mentoring program, and receive six semi-annual satisfactory evaluations by their employer within six years of receiving their Level I certification (Pennsylvania Department of Education, n.d.). Thirty-two participants (41.6%) participate in FCCLA and 45 participants (58.4%) do not participate in FCCLA. Of the sample, 55 people (71.4%) had FCS as their initial certification and 22 (28.6%) had another initial certification and took the Praxis to become FCS certified. On average, participants reported taking 8.88 STEM courses in college (*SD* = 1.31, *IQR*: 4, 12).

There were seven sections on the *Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey-Elementary Teachers*. Most survey questions were positively worded, like "I am confident that I can teach mathematics effectively." A few, however, are negatively worded, like "I wonder if I have the necessary skills to teach mathematics." The negatively worded questions were assigned values in the reverse order of all the other questions ("5" for strongly disagree, "4 for disagree," etc.), since agreement to those questions represents an attitude opposite of the attitude for agreement with the other questions. Items #5 and #9 in the both the Science and Mathematics Teaching Efficacy and Beliefs constructs were negatively worded. All other items were positively worded. See Appendix C for the complete *T-STEM Survey*.

The mean SCIEFF score was 3.40, (*SD* = .74, *Md*n = 3.64) with a moderately skewed distribution. SCIOUT had a mean score of 3.40 (*SD* = .46, *Mdn* = 3.44) with a symmetric distribution. MATHEFF had a mean score of 3.12 (*SD* = .80, *Mdn* = 3.18) with a moderately symmetric distribution. MATHOUT had a mean score of 3.30 (*SD* = .89, *Mdn* = 3.33) with a symmetric distribution. TECHUSE had a mean score of 3.30 (*SD* = .87, *Mdn* = 3.43) and a symmetric distribution. STEMINST had a mean of 2.85 (*SD* = .72, *Mdn* = 2.86) and a symmetric distribution. TWELEAR had a mean score of 4.51 (*SD* = .49, *Mdn* = 4.64) and a highly skewed, negative distribution. The distributions for TWELEAR were leptokurtic. All others were platykurtic.

**Table 3**

*Descriptive Statistics for Dependent Variables*

| Variable | *M* | *SD* | Minimum | Maximum |
|---|---|---|---|---|
| 1. SCIEFF | 3.40 | .74 | 1.36 | 4.82 |
| 2. SCIOUT | 3.40 | .46 | 2.44 | 4.44 |
| 3. MATHEFF | 3.12 | .80 | 1.27 | 5.00 |
| 4. MATHOUT | 3.30 | .89 | 2.44 | 4.00 |
| 5. TECHUSE | 3.30 | .87 | 1.50 | 5.00 |
| 6. STEMINST | 2.85 | .72 | 1.50 | 4.79 |
| 7. TWELEAR | 4.51 | .49 | 2.27 | 5.00 |

## Statistical Analysis

To address the research questions, simple linear regression analysis was performed to determine the predictive relationship between the independent variables and each of the teacher self-efficacy construct scores as the dependent variable. Table 4, adapted from Cohen (1992), identifies the effect sizes that were utilized for the regression analysis.

**Table 4**

*Table of Effect Sizes*

| $R^2$ Value | Effect Size |
|---|---|
| + .02 | small effect |
| + .13 | medium effect |
| + .26 | large effect |

Adapted from Cohen (1992)

***Participation in FCCLA***

For the independent variable, FCCLA Participation, and the first dependent variable, SCIEFF, the results of the regression indicated that the independent variable was not a significant predictor of science teaching efficacy beliefs, $F(1, 75) = .30$, $p = .587$, $R^2 < .01$. The model had small effect and explained 0.4% of the variance.

For the second dependent variable, SCIOUT, the results of the regression indicated the independent variable was not a significant predictor of science teaching outcome expectancy, $F(1, 75) = .36$, $p = .549$, $R^2 = .01$. The model had small effect and explained 1% of the variance.

Results of the third dependent variable, MATHEFF, indicated the independent variable was not a significant predictor of math teaching efficacy beliefs, $F(1, 75) = .06$, $p = .807$, $R^2 = .01$. The model had small effect and explained 1% of the variance.

The fourth dependent variable, MATHOUT, indicated that the independent variable was not a significant predictor of mathematics teaching outcomes expectancy, $F(1, 75) = 1.02$, $p = .316$, $R^2 = .01$. The model had small effect and explained 1% of the variance.

For the fifth dependent variable, TECHUSE, the results of the regression indicated the independent variable was not a significant predictor of teachers' perceptions of student technology use, $F(1, 75) = .70$, $p = .405$, $R^2 = .01$. The model had small effect and explained 1% of the variance.

For the sixth dependent variable, STEMINST, the results of the regression indicated the independent variable was not a significant predictor of STEM Instruction, $F(1, 75) = .20$, $p = .658$, $R^2 < .01$. The model had small effect and explained 0.3% of the variance.

The results for the seventh dependent variable, TWELEAR, indicated that the independent variable was not a significant predictor of 21st century learning attitudes, $F(1, 75)$ = .08, $p$ = .774, $R^2$ = .01. The model had small effect and explained 1% of the variance.

***Number of STEM Courses Taken***

For the variable independent variable, number of STEM courses taken, and the first dependent variable, SCIEFF, the results of the regression indicated the independent variable was not a significant predictor of science teaching efficacy beliefs, $F(1, 75)$ = 3.84, $p$ = .054, $R^2$ = .05. The model had small effect and explained 5% of the variance.

For the second dependent variable, SCIOUT, the results of the regression indicated the independent variable was not a significant predictor of science teaching outcome expectancy, $F(1, 75)$ = .1.21, $p$ = .275, $R^2$ = .02. The model had small effect and explained 1.6% of the variance.

Results of the third dependent variable, MATHEFF, indicated the independent variable was not a significant predictor of math teaching efficacy beliefs, $F(1, 75)$ = 2.00, $p$ = .659, $R^2$ = .03. The model had small effect and explained 3% of the variance.

The fourth dependent variable, MATHOUT, indicated that the independent variable was not a significant predictor of math teaching outcome expectancy, $F(1, 75)$ = 1.02, $p$ = .315, $R^2$ = .01. The model had small effect and explained 1.3% of the variance.

For the fifth dependent variable, TECHUSE, the results of the regression indicated the independent variable was not a significant predictor of teachers' perceptions of student technology use, $F(1, 75)$ = .50, $p$ = .482, $R^2$ = .01. The model had small effect and explained .7% of the variance.

The sixth dependent variable, STEMINST, the results of the regression indicated the independent variable was not a significant predictor of STEM Instruction, $F(1, 75) = 2.57$, $p = .113$, $R^2 = .03$. The model had small effect and explained 3.3% of the variance.

The results for the seventh dependent variable, TWELEAR, indicated that the independent variable was a significant predictor of 21st century learning attitudes, $\beta = .02$, $SE = .01$, $p = .019$. This indicates a positive relationship between the number of STEM course taken and the TWELEAR. The model had small effect and explained 7.1% of the variance.

***Educational Level***

For the independent variable, Educational Level, and the first dependent variable, SCIEFF, the results of the regression indicated that the independent variable was not a significant predictor of science teaching efficacy beliefs, $F(2, 74) = .23$, $p = .792$, $R^2 = .01$. The model had small effect and explained .6% of the variance.

For the second dependent variable, SCIOUT, the results of the regression indicated the independent variable was not a significant predictor of science teaching outcome expectancy, $F(2, 74) = .07$, $p = .937$, $R^2 < .01$. The model had small effect and explained .2% of the variance.

Results of the third dependent variable, MATHEFF, indicated the independent variable was not a significant predictor of math teaching efficacy beliefs, $F(2, 74) = .31$, $p = .736$, $R^2 = .01$. The model had small effect and explained .8% of the variance.

The fourth dependent variable, MATHOUT, indicated that the independent variable was not a significant predictor of math teaching outcome expectance, $F(2, 74) = .63$, $p = .534$, $R^2 = .02$. The model had small effect and explained 1.7% of the variance.

For the fifth dependent variable, TECHUSE, the results of the regression indicated that the independent variable was not a significant predictor of teachers' perceptions of student technology use, $F(2, 74) = .09$, $p = .916$, $R^2 < .01$. The model had small effect and explained .2% of the variance.

For the sixth dependent variable, STEMINST, the results of the regression indicated the independent variable was not a significant predictor of STEM Instruction, $F(2, 74) = .07$, $p = .931$, $R^2 < .01$. The model had small effect and explained .2% of the variance.

The results for the seventh dependent variable, TWELEAR, indicated that the independent variable was not a significant predictor of 21st century learning attitudes, $F(2, 74) = .91$, $p = .408$, $R^2 = .02$. The model had small effect and explained 2.4% of the variance.

***Years in Teaching***

For the variable independent variable, Years in Teaching, and the first dependent variable, SCIEFF, the results of the regression indicated the independent variable was not a significant predictor of science teaching efficacy beliefs, $F(1, 75) = 2.60$, $p = .111$, $R^2 = .03$. The model had small effect and explained 3% of the variance.

For the second dependent variable, SCIOUT, the results of the regression indicated the independent variable was not a significant predictor of science teaching outcome expectancy, $F(1, 75) = .28$, $p = .599$, $R^2 < .01$. The model had small effect and explained .4% of the variance.

Results of the third dependent variable, MATHEFF, indicated the independent variable was not a significant predictor of math teaching efficacy beliefs, $F(1, 75) = .20$, $p = .659$, $R^2 < .01$. The model had small effect and explained .3% of the variance.

The fourth dependent variable, MATHOUT, indicated that the independent variable was not a significant predictor of math teaching outcome expectancy, $F(1, 75) = .12$, $p = .725$, $R^2 < .01$. The model had small effect and explained .2% of the variance.

For the fifth dependent variable, TECHUSE, the results of the regression indicated the independent variable was not a significant predictor teachers' perceptions of student technology use, $F(1, 75) = .97$, $p = .328$, $R^2 = .01$. The model had small effect and explained 1% of the variance.

For the sixth dependent variable, STEMINST, the results of the regression indicated the independent variable was not a significant predictor of STEM Instruction, $F(1, 75) = .01$, $p = .921$, $R^2 < .01$. The model had small effect and explained 0% of the variance.

The results for the seventh dependent variable, TWELEAR, indicated that the independent variable was not a significant predictor of 21st century learning attitudes, $F(1, 75) = .308$, $p = .581$, $R^2 < .01$. The model had small effect and explained .4% of the variance.

***Gender***

Because all survey participants were female, this variable was a constant and no data were analyzed for this predictor.

A comprehensive list of means and standard deviations for the dependent and independent variables is available in Table 5.

**Table 5**

*Table of Means and Standard Deviations*

| Independent Variable | Dependent Variable | Mean | Standard Deviation |
|---|---|---|---|
| Participation in FCCLA | SCIEFF | Yes 3.35<br>No 3.44 | Yes .75<br>No .74 |
| Participation in FCCLA | SCIOUT | Yes 3.36<br>No 3.43 | Yes .49<br>No .45 |
| Participation in FCCLA | MATHEFF | Yes 3.15<br>No 3.11 | Yes .87<br>No .75 |
| Participation in FCCLA | MATHOUT | Yes 3.35<br>No 3.26 | Yes .38<br>No .39 |
| Participation in FCCLA | TECHUSE | Yes 3.40<br>No 3.23 | Yes .82<br>No .91 |
| Participation in FCCLA | STEMINST | Yes 2.89<br>No 2.82 | Yes .67<br>No .75 |
| Participation in FCCLA | TWELEAR | Yes 4.53<br>No 4.50 | Yes .58<br>No .43 |
| Number of STEM courses taken | SCIEFF | 3.40 | .74 |
| Number of STEM courses taken | SCIOUT | 3.40 | .46 |
| Number of STEM courses taken | MATHEFF | 3.12 | .80 |
| Number of STEM courses taken | MATHOUT | 3.30 | .39 |
| Number of STEM courses taken | TECHUSE | 3.30 | .87 |
| Number of STEM courses taken | STEMINST | 2.85 | .72 |
| Number of STEM courses taken | TWELEAR | 5.52 | .49 |
| Educational Level | SCIEFF | Bachelors 3.39<br>Masters 3.40<br>Doctorate 3.91 | Bachelors .63<br>Masters .77<br>Doctorate no SD available |
| Educational Level | SCIOUT | Bachelors 3.42<br>Masters 3.40<br>Doctorate 3.56 | Bachelors .46<br>Masters .47<br>Doctorate no SD present |
| Educational Level | MATHEFF | Bachelors 3.21<br>Masters 3.10<br>Doctorate 3.64 | Bachelors .78<br>Masters .81<br>Doctorate no SD present |
| Educational Level | MATHOUT | Bachelors 3.38<br>Masters 3.29<br>Doctorate 3.00 | Bachelors .33<br>Masters .40<br>Doctorate no SD present |
| Educational Level | TECHUSE | Bachelors 3.38<br>Masters 3.29<br>Doctorate 3.13 | Bachelors .76<br>Masters .90<br>Doctorate no SD present |
| Educational Level | STEMINST | Bachelors 2.92<br>Masters 2.84<br>Doctorate 2.79 | Bachelors .57<br>Masters .75<br>Doctorate no SD present |
| Educational Level | TWELEAR | Bachelors 4.39<br>Masters 4.55<br>Doctorate 4.09 | Bachelors .46<br>Masters .50<br>Doctorate no SD present |
| Years in Teaching | SCIEFF | 3.40 | .74 |
| Years in Teaching | SCIOUT | 3.40 | .46 |
| Years in Teaching | MATHEFF | 3.12 | .80 |
| Years in Teaching | MATHOUT | 3.30 | .39 |
| Years in Teaching | TECHUSE | 3.30 | .87 |
| Years in Teaching | STEMINST | 2.85 | .72 |
| Years in Teaching | TWELEAR | 4.51 | .49 |

## Summary

Chapter IV detailed the data screening, variable transformations and computations, as well as provided descriptive data and the results of data analysis. The data were analyzed according to their relationship with the research questions. Research question one explored the level of self-efficacy of FCS teachers regarding teaching STEM concepts. Research question two explored how each of the teacher demographic variables respectively predict the level of self-efficacy of FCS teachers when teaching STEM concepts. The five independent teacher demographic variables were participation in FCCLA, number of STEM courses taken, education level, number of years in teaching, and gender.

The seven sections on the *Teacher Efficacy and Attitudes Toward STEM Survey* were analyzed and the mean SCIEFF score was 3.40, ($SD = .74$, $Mdn = 3.64$). SCIOUT had a mean score of 3.40 ($SD = .46$, $Mdn = 3.44$). MATHEFF had a mean score of 3.12 ($SD = .80$, $Mdn = 3.18$) with a moderately symmetric. MATHOUT had a mean score of 3.30 ($SD = .89$). TECHUSE had a mean score of 3.30 ($SD = .87$). STEMINST had a mean of 2.85 ($SD = .72$). TWELEAR had a mean score of 4.51 ($SD = .49$). Overall, FCS teachers scored highest in 21st century learning attitudes and lowest in STEM instruction. The results indicated that the independent variable number of STEM courses taken was a significant predictor of 21st century learning attitudes ($\beta = .02$, $SE = .01$, $p = .019$). A detailed analysis of these findings will be presented in Chapter V.

# Chapter V

# CONCLUSIONS AND RECOMMENDATIONS

The problem of this study was to identify factors that may be related to family and consumer sciences teachers' self-efficacy in teaching STEM education to provide supports that improve teaching practices. This chapter summarizes the study, discusses the conclusions of the study, and provides recommendations based on the study findings.

## Summary

Education in science, technology, engineering, and mathematics (STEM) has become widely promoted as it is important to our economy that schools produce students capable of success in STEM fields. Quality STEM education could maintain or increase the number of individuals preparing for careers in these fields and increase STEM literacy for the population (Stohlmann et al., 2012) because it provides students with science, mathematics, engineering, and technology instruction that build upon each other and has real-world applications (Eberle, 2010). STEM education also creates critical thinkers and enables innovation (Eberle, 2010). According to the U.S. Bureau of Labor Statistics (2021), the fastest growing occupations require at least a basic, and for many a significant, understanding of STEM subjects (Eberle, 2010).

To promote STEM learning and literacy, research suggests an interdisciplinary approach that allows students to make real-world connections as they prepare for STEM pathways and careers (Gomez and Albrecht, 2013). El-Deghaidy and Mansour (2015) found that teachers acknowledge the benefits of STEM education, such as promoting 21st century skills, thinking skills, collaboration, problem solving, and research skills. They also identify that linking learning to real-life situations increases students' interest in STEM careers (El-Deghaidy & Mansour, 2015).

FCS education, as well as other CTE subject areas, have always had both a career and an academic focus. From its beginning, FCS education has used the resources of modern science to improve home life (Berlage, 1998), while also using principles of mathematics, engineering, and technology (Shirley & Kohler, 2012). FCS education provides students with tasks that require them to solve real-world problems with practical reasoning in a hands-on environment (Laster & Johnson, 2001).

With so much overlap in content and methodology, why is FCS not perceived as a bigger part of STEM education? Do FCS teachers feel confident in their ability to teach STEM concepts? What factors influence FCS teachers' self-efficacy in STEM education?

The problem of this study was to identify factors that may be related to family and consumer sciences teachers' self-efficacy in teaching STEM education to provide supports that improve teaching practices. To guide this study, the following research questions were asked:

1. What is the level of self-efficacy of FCS teachers regarding teaching STEM concepts?
    a. What is the level of FCS teachers' science teaching efficacy and beliefs?
    b. What is the level of FCS teachers' science teaching outcome expectancy?
    c. What is the level of FCS teachers' mathematics teaching efficacy and beliefs?
    d. What is the level of FCS teachers' mathematics teaching outcome expectancy?
    e. What is the level of FCS teachers' perceptions of student technology use?
    f. What is the level of FCS teachers' STEM instruction?
    g. What is the level of FCS teachers' 21st century learning attitudes?
2. How will each of the teacher demographic variables (i.e., participation in FCCLA, number of STEM courses taken, education level, number of years teaching, and gender)

respectively predict the level of self-efficacy of FCS teachers when teaching STEM concepts?

a. How will each teacher demographic variable predict FCS teachers' science teaching efficacy and beliefs?
b. How will each teacher demographic variable predict FCS teachers' science teaching outcome expectancy?
c. How will each teacher demographic variable predict FCS teachers' mathematics teaching efficacy and beliefs?
d. How will each teacher demographic variable predict FCS teachers' mathematics teaching outcome expectancy?
e. How will each teacher demographic variable predict FCS teachers' perceptions of student technology use?
f. How will each teacher demographic variable predict FCS teachers' STEM instruction?
g. How will each teacher demographic variable predict FCS teachers' 21st century learning attitudes?

This study had additional limitations discovered after analysis. TWELEAR had a highly skewed, leptokurtic distribution. Both MATHEFF and SCIEFF had a moderately skewed distribution. These factors could have impacted the normality assumption of linear regression. Because all survey responses were from females, the data may have been skewed. There was only one respondent that had a doctorate, so this may also have impacted the overall results.

The *T-STEM Survey for Elementary Teachers* instrument contained nine constructs: Personal STEM Teaching Efficacy and Beliefs (PSTEB), STEM Teaching Outcome Expectancy Beliefs (TOEB)—both of which include separate questions for science and mathematics—Student Technology Use, STEM Instruction, 21st Century Learning Attitudes, Teacher Leadership Attitudes, and STEM Career Awareness. The last two sections were deemed impertinent to this study and were removed. The other seven sections of the instrument were relevant. Teacher demographic information directly connected to the research variables was collected, namely participation in FCCLA, number of STEM courses taken, education level, number of years teaching, and gender. Data analysis began with an examination of descriptive data and then simple linear regression analysis was performed to determine the predictive relationship between the independent variables and each of the teacher self-efficacy construct scores as the dependent variable.

## Conclusions

The problem of this study was to identify factors that may be related to family and consumer sciences teachers' self-efficacy in teaching STEM education to provide supports that improve teaching practices. Research Question 1 looked at the level of self-efficacy of FCS teachers regarding teaching STEM concepts by looking at the overall scores on each section of the *T-STEM Survey.* The mean SCIEFF score was 3.40, indicating that teachers' fell between "neither agree nor disagree" and "agree." This section included questions about teachers' confidence in their science teaching skills, indicating that most feel slightly confident in their ability to teach science concepts. The mean SCIOUT score was 3.40, also indicating that participants fell between "neither agree nor disagree" and "agree." This section covers questions about the degree to which teachers believe they can affect students' learning in science with effective teaching, indicating that most FCS teachers feel slightly sure that they can affect students' learning in science. Though the instrument uses different descriptions, the findings somewhat align with the findings of Merrill's (2016) limited survey of 50 FCS teachers (a 25% response rate) that found FCS teachers viewed science integration as important, and they were fairly confident in their ability to integrate it. This study did not take into account any changes or policies related to COVID.

Although FCS educators mainly focus curriculum on the *National Standards for Family and Consumer Sciences* (NASAFACS, 2008-2018), they are also encouraged to find opportunities to draw connections with STEM standards to provide more STEM learning opportunities for students (Deaton et al., 2018). Deaton et al. (2018) provide an alignment of the *NGSS High School Life Science Standards* (NGSS Lead States, 2013) and the *NGSS High School Engineering, Technology, and the Applications of Science Standards* (NGSS Lead States, 2013) to the *National Standards for Family and Consumer Sciences* (NASAFACS, 2008-2018). As the overlap is clearly outlined, FCS teachers are likely teaching science content, but they may not recognize it as such. They may view the integrated science concepts as part of FCS and not view it as science, because it is not a standalone course in chemistry, physics, biology, or Earth science. Like other applied science, FCS has evolved with society and technology (AAFCS, n.d.) Teachers needing additional supports and clarity on STEM integration can find professional development opportunities through the American Association for Family and Consumer Sciences. They offer webinars on the current science and practice in food preservation, food science, STEM in baking, STEMIFYing the curriculum, and STEM integration (AAFCS Webinar Library, n.d.).

MATHEFF had a mean score of 3.12, again indicating that FCS teachers feel slightly confident in their mathematics teaching skills. MATHOUT had a mean score of 3.30, therefore, FCS teachers feel slightly sure that they can affect students' learning in mathematics. Similarly, Berleth (2020) surveyed 212 FCS teachers and the results revealed that teachers have a positive attitude towards mathematics integration within the FCS curriculum. Most of the surveyed teachers also made attempts to collaborate with their colleagues and other mathematics instructors on effective ways of integrating mathematics in their FCS courses. However, as in this study, Berleth (2020) found that individual self-efficacy for integrating mathematics among FCS teachers was low. As previously stated, FCS educators focus curriculum on the *National Standards for Family and Consumer Sciences* (NASAFACS, 2008-2018), but are also encouraged to draw connections with STEM standards to provide more STEM learning opportunities for students (Deaton et al., 2018). Carter et al. (2019) provided an alignment of the *National Standards for Family and Consumer Sciences* (NASAFACS, 2008-2018) and the *Common Core State Standards for Mathematics* (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010) and identified overlap and opportunities for STEM integrated learning opportunities. Again, FCS teachers may be integrating mathematics into their curriculum, but view it as part of their FCS curriculum, not as teaching mathematics.

In a national study, Berleth (2020) found that inadequate teaching resources, lack of prior training on mathematics integration, and limited knowledge or experience on how to integrate mathematics within the FCS curriculum contributed to low feelings of self-efficacy and teachers emphasized the need for institutional support. Merrill (2016) found similar results in Utah in science. This study makes similar conclusions in Pennsylvania. Where teachers are trained and the license requirements for that state may impact these studies. This shows a need for a larger, national study of FCS teachers. The American Association for Family and Consumer Sciences offers professional development opportunities on financial wellness, STEMIFYing the FCS classroom, teaching STEM through FCS education, money smarts and financial literacy, personal finance, and investing (AAFCS Webinar Library, n.d.).

TECHUSE addresses the frequency that teachers perceive students use technology and had a mean score of 3.30. This suggests that students in FCS classes use technology more than half of the time. Reddy et al. (2020) postulate that classroom technology is intended to expose students to tools related to their future professions. Likewise, FCS aims to prepare future professionals through research, experiential education, and technology (Reddy et al., 2020). Similarly, the questions in this portion of the survey focus on the use of technology to communicate, collaborate, research, simulate, solve-problems, and use higher-order thinking. FCS teachers may instead be using technology to augment and modify learning. These studies and the *T-STEM Survey* limit the definition of technology to instructional technology. Perhaps teachers would rank technology use higher if they used a broader definition of technology. For example, ITEEA (2020) defines technology as the human designed world. This definition encompasses the many tools, materials, and equipment that FCS teachers regularly use in their classrooms.

If, as Merrill (2016) purposed, integration of technology is an area of least confidence for FCS teachers, they may require support with new lesson plans, labs, and easily accessible resources. When working to improve teachers' use of technology, Reddy et al. (2020) identified a major challenge for FCS teachers may not be integrating technology tools but updating these tools within a short period of time. Reddy et al. also points out that adopting technology in education is not easy and requires time that teachers may not have to spend on it and encourages considering the differences in teachers. Differences can be based on (a) instructor's preference for either a teaching-focused approach or learning-focused approach, (b) technological competence of a teacher, (c) the ability of teachers to adapt to new technologies, and (d) the attitude of teachers toward integrating new technology (Reddy et al., 2020). Professional development should meet teachers where they are and help them to move forward from there. AAFCS offers professional development on game-based learning and technology for high level thinking, as well as FCS tech talks (AAFCS Webinar Library, n.d.).

STEMINST had a mean of 2.85 and was the section with the lowest average score. This score implies that between "occasionally" and "about half the time" teachers are engaging in STEM-based instruction. As previously discussed, teachers may be unaware of ways in which they are currently providing STEM-based instruction because the FCS curriculum is so closely aligned with other STEM-based standards. For example, the FCCLA Planning Process has clear connections to the *Next Generation Science Standards* (Carter et al., 2015). Both acknowledge the importance of 21st century skills and both require students to solve problems, think critically, and develop the necessary tools for approaching a problem (Carter et al., 2015). Both guide students toward an inquiry-based approach to learning (Carter et al., 2015). This study did not look at teachers' interests in integrating STEM, but Merrill (2016) found that FCS teachers were willing and enthusiastic about integrating more STEM into the teaching, especially in foods courses. AAFCS offers professional development on STEMIFYing the FCS curriculum, teaching STEM through FCS, and teaching STEM through baking (AAFCS Webinar Library, n.d.).

Overall, FCS teachers scored highest in 21st century learning attitudes. TWELEAR had a mean score of 4.51, denoting that FCS teachers "agree" or "strongly agree" that it is important to provide learning opportunities that support 21st century learning attitudes. Twenty-first century learning attitudes are those that promote students as active, inventive, creative learners who think critically (Shernoff, et al., 2017). *T-STEM Survey* questions focused on whether or not student have opportunities to produce high quality work, set their own learning goals, manage time and prioritize assignments, and work with others. These results could indicate that FCS teachers would benefit from coursework or professional development designed specifically to increase STEM self-efficacy, especially in the areas of science, mathematics, and STEM instruction. This is similar to Merrill (2016) who also found that respondents in their study desired support with new lesson plans, labs, and easily accessible resources. Teachers were interested in more summer conferences, e-newsletters with resources, webinars, study groups, or a combination of these items (Merrill, 2016).

Research Question 2 looked at the ability of the teacher demographic variables (i.e., participation in FCCLA, number of STEM courses taken, education level, number of years teaching, and gender) to predict the level of self-efficacy of FCS teachers when teaching STEM concepts. Each construct from the *T-STEM Survey* was analyzed with each demographic variable. Of these factors, the independent variable number of STEM courses taken was a significant predictor of 21st century learning attitudes ($\beta = .02$, $SE = .01$, $p = .019$). No other factors were significant predictors. In contrast, Berleth (2020) identified that FCS teachers' self-efficacy when teaching mathematics concepts was correlated with a teacher's level of education, years of teaching experience, and the grade level that teachers taught in school.

Of the participants ($n = 77$), 77 were females (100%), therefore, this factor was removed from the regression. Perhaps data from multiple genders would have impacted the outcome of the analysis. Thirteen participants had a bachelor's degree (16.9%), 63 had a master's degree

(81.8%), and one had a doctoral degree (1.3%). Having more participants with doctoral degrees may have impacted the outcome of the analysis. On average, participants reported taking 8.88 STEM courses in college (*SD* = 1.31, *IQR*: 4, 12). This may have been confusing for participants, because they may have been unsure what to consider a STEM course, despite it being defined in the survey.

## Recommendations

Based on the finding and conclusions of this study, the following are recommendations for researchers and practitioners.

### *Future Research*

This study focused on the factors that may be related to family and consumer sciences teachers' self-efficacy in teaching STEM education to provide supports that improve teaching practices; however, the sample was limited to FCS teachers in Pennsylvania. Given the number of FCS teachers across the country and the different license requirement in each state, the data may be more representative if it was distributed nationwide. This could be accomplished with the state and national FCS Associations.

Of the sample, 55 people (71.4%) had FCS as their initial certification and 22 (28.6%) had another initial certification and took the Praxis to become FCS certified. This may have been an additional variable worth exploring to determine whether teachers from other subject certification areas feel a greater sense of self-efficacy when integrating STEM than those with FCS as their initial certification.

The survey focus was purely quantitative. A mixed method study or additional qualitative study could use interviews and focus groups to get a more detailed picture of how FCS teachers feel about STEM education and their STEM self-efficacy. Common themes that emerge in the interviews or focus groups could be explored as additional factors for future research.

An aim of this study was to use the resulting information to provide supports to improve teaching practices. This study identified a positive effect of the number of STEM courses on FCS teachers' 21st century learning attitudes score. Policymakers and teacher preparation programs may then benefit from increasing the number of STEM courses required for teachers as a means of improving 21st century learning opportunities. It may be useful to offer a STEM-specific course or professional development opportunity for FCS teachers and use the *T-STEM Survey* as a pretest and posttest to determine its effectiveness. AAFCS offers a variety of professional development opportunities related to integrated STEM. Pennsylvania recognizes a STEM education endorsement that teachers can add to an existing state licensure and is designed to provide additional knowledge and promote skills related to more integrative ways to deliver content in these areas. The endorsement is aimed at creating opportunities to integrate student-centered learning approaches in all content areas to improve the quality of K-12 education and interaction with the larger community (Pennsylvania Department of Education, 2014). Programs develop teachers' skills in analysis, problem solving, and critical thinking through active project-based learning. The core content knowledge required of the endorsement programs includes:

1. Knowledge of standards, design processes, and the important role of STEM in workforce preparation.
2. Application and demonstration of STEM skills.
3. Implementation of best practices in integrative-STEM education.
4. Assessment of integrative-STEM learning in the classroom (Pennsylvania Department of Education, 2014).

By offering these endorsements, or something similar in other states, to teachers in all disciplines or incorporating similar content knowledge into teacher education programs, teachers may have a better understanding of integrated-STEM and feel a higher degree of self-efficacy when teaching STEM.

Evaluating the course offerings required in pre-service FCS education programs could allow researchers to see what courses or extracurriculars might contribute to increased levels of STEM self-efficacy. An audit of all undergraduate programs could be conducted.

While this study measured a participant's STEM self-efficacy at a single moment in time, a longitudinal study that measures STEM self-efficacy at the beginning of their teaching career and then at five and 10 years may be beneficial and provide a different perspective on the relationship between STEM self-efficacy, years of experience, and possibly additional degrees. Similar studies could also be conducted in other areas of career and technical education in order to determine teachers' STEM self-efficacy. The same factors could be used to conduct a regression. This would strengthen the body of knowledge on integrated STEM within CTE. Chen et al. (2021) found that preservice preschool teachers who had STEM teaching experience, interests in STEM, or participated in STEM-related activities reported higher levels of STEM self-efficacy. These factors could be utilized in a future study.

Finally, it may be beneficial to design a STEM self-efficacy tool or survey that is specific to FCS or CTE teachers. Two sections of the survey were removed, because they were not relevant to this study. The *T-STEM* surveys designed for separate subject area teachers may not have been sensitive enough for the content areas covered in FCS. Additionally, the survey may have been confusing to non-subject area teachers. Consequently, designing and piloting an instrument focused on FCS may supply additional results and could further contribute to the current body of knowledge on integrated STEM education. Development of an instrument that provides a single, cumulative STEM self-efficacy score would also benefit the field.

***Implications for Practitioners***

The problem of this study was to identify factors that may be related to family and consumer sciences teachers' self-efficacy in teaching STEM education to provide supports that improve teaching practices. Bandura's (1977) social cognitive theory is the basis of self-efficacy research and teacher efficacy research (Seals et al., 2017). Teacher perceptions of student engagement are a significant predictor of teacher efficacy (Ross et al., 1996). Consequently, it is important to evaluate teachers' efficacy in specific contexts while teaching specific content (Ross et al., 1996). Quality STEM education should lead to STEM literacy (Jackson & Mohr-Schroeder, 2018), but STEM educators need to be both STEM literate and comfortable with STEM methods to be successful (Zollman, 2012).

Quality STEM education provides students with science, mathematics, engineering, and technology instruction that build upon each other and has real-world applications (Eberle, 2010). Further, STEM education creates critical thinkers and enables innovation, which leads to new products and processes to sustain the economy (Eberle, 2010). The fastest growing occupations require at least a basic, and for many a significant, understanding of STEM subjects (U.S. Bureau of Labor Statistics, 2021); therefore, it is essential that as a nation, we make STEM education a top priority (Eberle, 2010). To promote STEM learning and literacy, schools must ground STEM pedagogy in research which advocates for an interdisciplinary approach that allows students to make real-world connections (Gomez and Albrecht, 2013). FCS education has always used the resources of modern science to improve home life (Berlage, 1998), while also using principles of mathematics, engineering, and technology (Shirley & Kohler, 2012).

FCS education, like integrated STEM education, provides students with tasks that require them to solve real-world problems with practical reasoning in a hands-on environment (Laster & Johnson, 2001). FCS courses seek to increase students' overall academic success by drawing connections between FCS courses and other academic subjects (Carter et al., 2015). Although FCS educators focus curriculum on the *National Standards for Family and Consumer Sciences* (NASAFACS, 2008-2018), they are encouraged to find opportunities to draw connections with STEM standards to provide more STEM learning opportunities for students (Deaton et al., 2018). For example, Deaton et al. (2018) clearly identify the overlap and alignment of the *NGSS High School Life Science Standards* (NGSS Lead States, 2013) and the *NGSS High School Engineering, Technology, and the Applications of Science Standards* (NGSS Lead States, 2013) to the *National Standards for Family and Consumer Sciences* (NASAFACS, 2008-2018). Carter et al. (2019) and Carter et al. (2015) did the same with the *National Standards for Family and Consumer Sciences* (NASAFACS, 2008-2018) and the *Common Core State Standards for Mathematics* (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010), and the FCCLA Planning Process and the *Next Generation Science Standards* (Carter et al., 2015). With so much overlap, we can conclude that FCS teachers are in fact teaching and integrating STEM. However, they may not be aware of it or view it as FCS content.

Within CTE, curriculum integration helps students make connections between academic subjects (Stone, 2011). Integrated learning models are context-based and try to fit traditional core subjects, especially STEM, into the CTE curriculum by starting with the CTE curriculum and enhancing the academic content naturally occurring in it. Generally, the problem is not finding areas to embed STEM learning in CTE programs, but how to support teachers move to integrate

STEM into their classrooms (Merrill & Lawver, 2019). More research is needed to determine if teachers are unable to integrate STEM into their subjects or if they are integrating STEM without realizing because they view STEM and FCS as one in the same. An instrument should be designed to focus on this issue.

Teachers can facilitate or impede students' STEM talent (Margot & Kettler, 2019). Teachers recognize the value of STEM education and acknowledge its importance in promoting 21st century skills, but they are concerned that they are underprepared to use STEM applications within their classrooms (El-Deghaidy & Mansour, 2015). To provide in-depth, authentic, problem-based STEM education, teachers need the necessary skills. They must feel comfortable creating a classroom environment that is student-centered (Margot & Kettler, 2019).

Merrill (2016) found that most FCS teachers felt competent to teach new standards related to STEM within their foods curriculum but were seldom given appropriate professional development to do so in areas they did not feel competent to teach. Berleth (2020) revealed that teachers have a positive attitude towards mathematics integration within the FCS curriculum, but their self-efficacy was low due to inadequate teaching resources, and lack of prior training on math integration. FCS teachers emphasized the need for institutional support, relevant teaching materials, and regular workshops to help them acquire adequate skills in math integration within the FCS curriculum. Findings support the need for increased professional development training in STEM-related fields to strengthen the FCS teachers' ability to teach STEM concepts in class, leading to a higher level of self-efficacy (Merrill & Lawver, 2019). In conclusion, FCS teachers show high support for STEM integration within FCS and learning institutions should leverage on this positive attitude to educate more teachers on effectively integrating STEM concepts within the FCS curriculum.

**REFERENCES**

Advance CTE. (2021). *Career technical education*. https://careertech.org/CTE

American Association of Family and Consumer Sciences (AAFCS). (n.d.). https://www.aafcs.org/about/about-us/faqs#:~:text=There%20are%20approximately%205%20million,of%20life%20today%20and%20tomorrow

American Association of Family and Consumer Sciences (AAFCS) Webinar Library. (n.d). https://www.aafcs.org/aafcs-events/all-events/archive-webinars

Asunda, P. A. (2014). A conceptual framework for STEM integration into curriculum through career and technical education. *Journal of STEM Teacher Education*, *49*(1), 4. doi.org/10.30707/JSTE49.1Asunda

Association for Career and Technical Education (ACTE). (2019). *A brief history of CTE*. https://www.acteonline.org/wp-content/uploads/2019/06/BriefHistoryofCTE-Timeline-June2019.pdf

Association of Career and Technical Education (2017). *College and career ready through CTE.* https://www.acteonline.org/wp-content/uploads/2018/03/ACTE-NRCCUA-College-and-Career-Ready-Infographic-2016.pdf

Bandura, A. (1991). Social cognitive theory of self-regulation. *Organizational Behavior and Human Decision Processes*, *50*(2), 248-287.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavior change. *Psychological Review, 84*(2), 191-215. http://dx.doi.org/10.1037/0033-295X.84.2.191

Bartoshuk, L. M. (2000). Comparing sensory experiences across individuals: Recent psychophysical advances illuminate genetic variation in taste perception. *Chemical Senses*, *25*(4), 447-460. https://doi.org/10.1093/chemse/25.4.447

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House*, *83*(2), 39-43.

Bennett, C. (1937). *History of manual training and industrial arts education 1870-1917*. Manual Arts Press.

Berlage, N. K. (1998). The establishment of an applied social science: Home economists, science, and reform at Cornell University, 1870-1930. *Gender and American Social Science: The Formative Years*, 185-231.

Berleth, N. (2020). *Determining the integration of mathematical concepts in family and consumer sciences education* (Doctoral dissertation). https://hdl.handle.net/2346/86637

Broussard, K. A., Warner, R. H., & Pope, A. R. (2018). Too many boxes, or not enough? Preferences for how we ask about gender in cisgender, LGB, and gender-diverse samples. *Sex Roles, 78*(9), 606-624.

Brown, R., Brown, J., Reardon, K., & Merrill, C. (2011). Understanding STEM: Current Perceptions. *Technology and Engineering Teacher*, *70*(6), 5-9. https://www.iteea.org/Publications/Journals/TET.aspx

Bybee, R. W. (2010). Advancing STEM education: A 2020 vision. *Technology and Engineering Teacher, 70*(1), 30-35. https://www.iteea.org/Publications/Journals/TET.aspx

Carl D. Perkins Career and Technical Education Improvement Act of 2006. Pub. L. No. 109-270, 120 Stat. 683 (2006).

Carter, V., Beachner, M., & Daugherty, M. K. (2015). Family and consumer sciences and STEM integration. *Journal of Family & Consumer Sciences*, *107*(1), 55-59.

Carter, V., Deaton, S., & Orr, B. (2019). Making connections: Interdisciplinary mathematics and Family and consumer sciences integration. *Journal of Family and Consumer Sciences*, *111*(2), 61-66. DOI: 10.14307/JFCS111.2.61

Casale-Giannola, D. (2011). Inclusion in CTE- What works and what needs fixin'. *Tech Directions, 70*, 21-23.

Chen, Y. L., Huang, L. F., & Wu, P. C. (2021). Preservice preschool teachers' self-efficacy in and need for STEM education professional development: STEM pedagogical belief as a mediator. *Early Childhood Education Journal*, *49*(2), 137-147. https://doi.org/10.1007/s10643-020-01055-3

Cohen, J. (1992). Quantitative methods in psychology: A power primer. *Psychological Bulletin*, 112, 155-159.

Committee on STEM Education. (2018). *Charting a course for success: America's strategy for STEM education*. Executive Office of the President. https://files.eric.ed.gov/fulltext/ED590474.pdf

CORD Communications, Inc. (CORD). (1999a). *Teaching mathematics contextually. The cornerstone of tech prep.* https://dl.icdst.org/pdfs/files/cf463a4e2f3afb0f7c94001fa54751d3.pdf

CORD Communications, Inc. (CORD). (1999b). *Teaching science contextually. The cornerstone of tech prep.* http://eksis.ditpsmk.net/uploads/book/file/838640CF-B5E5-4517-A3C8-67010DA4F3DC/Teaching_Science_Contextually.pdf

Corkett, J., Hatt, B., & Benevides, T. (2011). Student and teacher self-efficacy and the connection to reading and writing. *Canadian Journal of Education, 34*(1), 65-98. https://www.jstor.org/stable/10.2307/canajeducrevucan.34.1.65

Deaton, S., Carter, V., & Daugherty, M. K. (2018). Getting back to the roots of family and consumer sciences education: FCS and STEM integration. *Journal of Family & Consumer Sciences*, *110*(1), 55-58.

Dougherty, S. M., & Harbaugh Macdonald, I. (2020). Can growth in the availability of STEM technical education improve equality in participation?: Evidence from Massachusetts. *Journal of Vocational Education & Training*, *72*(1), 47-70.

Eberle, F. (2010). Why STEM education is important. *Intech, 57*(5), 62.

El-Deghaidy, H., & Mansour, N. (2015). Science teachers' perceptions of STEM education: Possibilities and challenges. *International Journal of Learning and Teaching*, *1*(1), 51-54. http://www.ijlt.org/uploadfile/2015/0824/20150824063944539.pdf

Enoch, G. L., Smith, P. L., Huinker, D. (2000). Establishing factorial validity of the mathematics teaching efficacy beliefs instrument. *School Science and Mathematics*, *100*(4), 194 -202.

Etheredge, J., Moody, D., & Cooper, A. (2014). Improving FCS accountability: Increasing STEM awareness with interior design modules. *Journal of Family and Consumer Sciences, 106*(4), 7.

Every Student Succeeds Act of 2015, Pub. L. No. 114-95.

Family, Careers, and Community Leaders of America (FCCLA). (n.d.). https://fcclainc.org

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*, 1149-1160. https://link.springer.com/article/10.3758/BRM.41.4.1149

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, 175-191. https://link.springer.com/article/10.3758/BF03193146

Forsythe, J., & Weintraub, F. (1969, May). The Vocational Education Amendments of 1968, Public Law 90-576. *Exceptional Children, 35*(9), 751.

Friday Institute for Educational Innovation (2012). *Teacher efficacy and attitudes toward STEM survey-elementary teachers*.

Friday Institute for Educational Innovation (2012). *Teacher efficacy and beliefs toward STEM Survey*.

Gagné, F. (2007). Ten commandments for academic talent development. *Gifted Child Quarterly*, *51*(2), 93-118. https://doi.org/10.1177/0016986206296660

Garrison, A. K. (2007). *The benefits of the FCCLA student organization: A grounded theory study* (3294141). [Doctoral dissertation, University of Wisconsin]. ProQuest Dissertations & Theses Global.

Gomez, A., & Albrecht, B. (2013). True STEM education. *Technology and Engineering Teacher*, *73*(4), 8. https://www.iteea.org/Publications/Journals/TET.aspx

Gordon, H. R., & Schultz, D. (2020). *The history and growth of career and technical education in America* (5th ed.). Waveland press.

Gordon, H. R. (2014). *The history and growth of career and technical education in America* (4th ed.). Waveland press.

Han, S., Yalvac, B., Capraro, M. M., & Capraro, R. M. (2015). In-service teachers' implementation and understanding of STEM project-based learning. *Eurasia Journal of*

*Mathematics, Science & Technology Education*, *11*(1), 63-76. https://doi.org/10.12973/eurasia.2015.1306a.

Honey, M., Pearson, G., & Schweingruber, A. (2014). *STEM integration in K-12 education: Status, prospects, and an agenda for research*. National Academies Press. https://nap.nationalacademies.org/catalog/18612/stem-integration-in-k-12-education-status-prospects-and-an

Hyslop, A. (2018). *Perkins V: The official guide to the Strengthening Career and Technical Education for the 21st Century Act*. Association for Career and Technical Education.

Independent Action, 1826-1876. (1976). *American Vocational Journal.* https://www.acteonline.org/wp-content/uploads/2018/02/Independent-Action_1826-1876.pdf

International Technology and Engineering Educators Association (ITEEA). (2020). *Standards for technological and engineering literacy: The role of technology and engineering in STEM education*. www.iteea.org/STEL.aspx

Keith, T. Z. (2015). *Multiple regression and beyond: An introduction to multiple regression and structural equation modeling* (2nd ed.). Routledge.

Kelley, T.R., Knowles, J.G. (2016) A conceptual framework for integrated STEM education. *International Journal of STEM Education, 3*(11). https://doi.org/10.1186/s40594-016-0046-z

Kennedy, T. J., & Odell, M. R. L. (2014). Engaging students in STEM education. *Science Education International*, *25*(3), 246-258. https://files.eric.ed.gov/fulltext/EJ1044508.pdf

Laster, J. & Johnson, J. (2001). Major trends in family and consumer sciences. http://www.ascd.org/publications/curriculum-handbook/394/chapters/Major-Trends-in-Family-and-Consumer-Sciences.aspx

LEADFCS. (n.d.). *Framework for family and consumer sciences in CTE.* http://www.leadfcsed.org/career-pathways-through-fcs.html

Leedy, P. D., Ormrod, J. E., & Johnson, L. R. (2019). *Practical research: Planning and design* (12th ed.). Pearson.

Liceaga, A., Ballard, T., & Esters, L. (2014). Increasing content knowledge and self-efficacy of high school educators through an online course in food science. *Journal of Food Science Education, 13*(2), 28-32. doi: 10.1111/1541-4329.12028

Louis S. Nadelson & Anne L. Seifert (2017) Integrated STEM defined: Contexts, challenges, and the future. *The Journal of Educational Research*, *110*(3), 221-223. https://doi.org/10.1080/00220671.2017.1289775

Mahmoee, H. M., & Pirkamali, A. (2013). Teacher self-efficacy and students' achievement: A theoretical overview. *The Social Sciences, 8*(2), 196-202.

Margot, K. C., & Kettler, T. (2019). Teachers' perception of STEM integration and education: a systematic literature review. *International Journal of STEM Education*, *6*(1), 2.

Merrill, C. A. (2016). Family and Consumer Sciences Teacher Needs Assessment of a STEM-Enhanced Food and Nutrition Sciences Curriculum. [Graduate thesis, Utah State University]. https://digitalcommons.usu.edu/etd/5216

Merrill, C., & Daugherty, J. (2009). The future of TE master's degrees: STEM. Presentation at the 70th Annual International Technology Education Association Conference, Louisville, Kentucky.

Merrill, C. A., & Lawver, R. G. (2019). Integration of science, technology, engineering, and math into a food and nutrition curriculum in Utah. *Family and Consumer Sciences Research Journal*, *48*(1), 37-51. DOI: 10.1111/fcsr.12326

Moore, T. J., Stohlmann, M. S., Wang, H. H., Tank, K. M., Glancy, A. W., & Roehrig, G. H. (2014). Implementation and integration of engineering in K-12 STEM education. *In Engineering in pre-college settings: Synthesizing research, policy, and practices* (pp. 35-60). Purdue University Press.

Mojavezi, A., & Tamiz, M. P. (2012). The impact of teacher self-efficacy on the students' motivation and achievement. *Theory & Practice in Language Studies, 2*(3). doi:10.4304/tpls.2.3.483-491

Nadelson, L. S., & Seifert, A. L. (2017). Integrated STEM defined: Contexts, challenges, and the future. *Journal of Educational Research*, *110*(3), 221-223. https://doi.org/10.1080/00220671.2017.1289775

National Academy of Engineering and National Research Council [NAE & NRC]. (2014). *STEM integration in K-12 education: Status, prospects, and an agenda for research*. National Academies Press.

National Association of State Administrators of Family and Consumer Sciences (NASAFACS). (2008-2018). *National standards for family and consumer sciences education.* https://opi.mt.gov/Portals/182/Page%20Files/Career%20%26%20Technical%20Education/Docs/FCS/15FCS_NationalStandards.pdf

National Center for Education Statistics. (2013). *Among public school graduates who earned credits in each career and technical education subject area, percentage who also earned* *credits in each other CTE subject area: 2013.* https://nces.ed.gov/surveys/ctes/tables/h192.asp

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards for Mathematics.* http://www.corestandards.org/Math/

National Research Council (NRC). (2010). *Exploring the intersection of science education and 21st century skills: A workshop summary.* National Academies Press. https://nap.nationalacademies.org/catalog/12771/exploring-the-intersection-of-science-education-and-21st-century-skills

National Research Council (NRC). (2014). *STEM learning is everywhere: Summary of a convocation on building learning systems.* The National Academies Press. https://nap.nationalacademies.org/catalog/18818/stem-learning-is-everywhere-summary-of-a-convocation-on-building

Next Generation Science Standards (NGSS) Lead States (2013). *Next Generation Science Standards: For States, By States*. https://www.nextgenscience.org/sites/default/files/AllDCI.pdf

Nickols, S. Y., Ralston, P. A., Anderson, C., Browne, L., Schroeder, G., Thomas, S., & Wild, P. (2009). The family and consumer sciences body of knowledge and the cultural kaleidoscope: Research opportunities and challenges. *Family and Consumer Sciences Research Journal*, *37*(3), 266-283. https://doi.org/10.1177/1077727X08329561

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological review*, *84*(3), 231. https://doi.org/10.1037/0033-295X.84.3.231

No Child Left Behind (NCLB) Act of 2001, Pub. L. No. 107-110, § 101, Stat. 1425 (2002).

Ogle, J., Hyllegard, K., Rambo-Hernandez, K., & Park, J. (2017). Building middle school girls' self-efficacy, knowledge, and interest in math and science through the integration of fashion and STEM. *Journal of Family and Consumer Sciences, 109*(4), 33-40. http://dx.doi.org/10.14307/JFCS109.4.33

Palombit, R. A. (2019). A framework for leveraging family and consumer sciences in CTE. *Techniques*, *94*(4), 16-21. http://www.leadfcsed.org/uploads/1/8/3/9/18396981/april19_techmagazine_palombit.pdf

Pathways to College and Career Readiness Career Clusters. (n.d.). https://cte.careertech.org/sites/default/files/CareerClustersPathways_0.pdf

Pennsylvania Department of Education. (n.d.). Certification. https://www.education.pa.gov/Educators/Certification/Pages/default.aspx

Pennsylvania Department of Education. (2014). The framework for integrative science, technology, engineering, and mathematics (STEM) education endorsement guidelines. https://www.education.pa.gov/Documents/Teachers-Administrators/Certification%20Preparation%20Programs/Specific%20Program%20Guidelines/Integrative%20Science,%20Technology,%20Engineering,%20Mathematics%20(STEM)%20Education%20Guidelines.pdf

Prentiss Bennett, J. M. (2016). An investigation of elementary teachers' self-efficacy for teaching integrated science, technology, engineering, and mathematics (STEM) education [Doctoral dissertation, Regent University].

Quackenbush, Melissa. (2020). *The Effects of self-regulated learning training on teachers' self-regulated learning, self-efficacy for teaching, and perceived instructional effectiveness in* *computer-supported collaborative learning environments*. [Doctoral dissertation, Old Dominion University]. Digital Commons. DOI: 10.25777/71md-j084

Reddy, S., & Bubonia, J. (2020). Technology in education: Learning opportunities for teachers and students. *Journal of Family and Consumer Sciences, 112*(1), 46-50. DOI: http://dx.doi.org/10.14307/JFCS112.1.46

Roberts, A. (2012). A justification for STEM education. *Technology and engineering teacher*, May/June 2012. https://www.iteea.org/File.aspx?id=86478&v=5409fe8e

Rosenthal, Robert, and Ralph L. Rosnow. 2008. Essentials of Behavioral Research: Methods and Data Analysis. Third Edition. New York: McGraw-Hill. http://nrs.harvard.edu/urn-3:HUL.InstRepos:34945148

Ross, J. A., Cousins, J. B., & Gadalla, T. (1996). Within-teacher predictors of teacher efficacy. *Teaching and teacher education*, *12*(4), 385-400.

Sanders, M. E. (2008). STEM, STEM education, STEMmania. https://vtechworks.lib.vt.edu/bitstream/handle/10919/51616/STEMmania.pdf?sequence=1&isAllowed=y

Savery, J. R. (2015). Overview of problem-based learning: Definitions and distinctions. *Essential readings in problem-based learning: Exploring and extending the legacy of Howard S. Barrows*, *9*(2), 5-15.

Seals, C., Mehta, S., Berzina-Pitcher, I., & Graves-Wolf, L. (2017). Enhancing teacher efficacy for urban STEM teachers facing challenges to their teaching. *Journal of Urban Learning, Teaching, and Research*, *13*, 135-146.

Shernoff, D. J., Sinha, S., Bressler, D. M., & Ginsburg, L. (2017). Assessing teacher education and professional development needs for the implementation of integrated approaches to

STEM education. *International Journal of STEM Education*, *4*(1), 13. http://www.ijlt.org/uploadfile/2015/0824/20150824063944539.pdf

Shirley, L. M., & Kohler, J. (2012). Clothing and textiles: Reinforcing STEM education through family and consumer sciences curriculum. *Journal of Family & Consumer Sciences Education*, *30*(2). https://natefacs.org/Pages/v30no2/v30no2Shirley.pdf

Skaalvik, E. M., & Skaalvik, S. (2010). Teacher self-efficacy and teacher burnout: A study of relations. *Teaching and Teacher Education*, 26, 1059-1069. http://dx.doi.org/10.1016/j.tate.2009.11.001

Smith, K. L., Rayfield, J., & McKim, B. R. (2015). Effective practices in STEM integration: Describing teacher perceptions and instructional method use. *Journal of Agricultural Education*, *56*(4), 182–201. DOI: 10.5032/jae.2015.04183

Smithsonian Science Education Center. (2020). *The STEM imperative*. https://ssec.si.edu/stem-imperative

Srikoom, W., & Faikhamta, C. (2018). Assessing in-service teachers' self-efficacy and beliefs about STEM education. *Journal of Education*, 12. https://www.researchgate.net/profile/Wachira-Srikoom/publication/331485238_Assessing_In-service_Teachers'_Self-efficacy_and_Beliefs_about_STEM_Education/links/5c7c8df8a6fdcc4715aca72e/Assessing-In-service-Teachers-Self-efficacy-and-Beliefs-about-STEM-Education.pdf

Stohlmann, M., Moore, T., & Roehrig, G. (2012). Considerations for teaching integrated STEM education. *Journal of Pre-College Engineering Education Research., 2*(1), 28–34. doi:10.5703/1288284314653.

Stone III, J. R. (2011). *Delivering STEM education through career and technical education schools and programs*. In workshop of committee on Highly Successful Schools or Programs for K-12 STEM Education. National Research Council, Washington, DC. https://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_072641.pdf

Stone III, J. R., Alfeld, C., Pearson, D., Lewis, M. V., & Jensen, S. (2006). Building academic skills in context: Testing the value of enhanced math learning in CTE. *National research center for career and technical education*. http://www.lions.odu.edu/org/deca/seps787/Reading2_CTE_(Math)BuildingAcademicSkills.pdf

Strengthening Career and Technical Education for the 21st Century Act (Perkins V), Pub. L. 115-224 (2018). http://www.congress.gov/bill/115th-congress/house-bill/2353

Tschannen-Moran, M., Hoy, A. W., & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. *Review of educational research*, *68*(2), 202-248. https://www-jstor-org.proxy.lib.odu.edu/stable/1170754?seq=1#metadata_info_tab_contents

Tschannen-Moran, M., & McMaster, P. (2009). Sources of self-efficacy: Four professional development formats and their relationship to self-efficacy and implementation of a new teaching strategy. *The Elementary School Journal*, *110*(2), 228-245. doi:10.1086/605771

Unfried, A., Rachmatullah, A., Alexander, A., & Wiebe, E. (2022). An alternative to STEBI-A: validation of the T-STEM science scale. *International Journal of STEM Education*, *9*(1), 1-14. https://stemeducationjournal.springeropen.com/articles/10.1186/s40594-022-00339-x

United States Bureau of Labor Statistics. (2021, September 8). *Employment in STEM occupations.* https://www.bls.gov/emp/tables/stem-employment.htm

United States Bureau of Labor Statistics. (2021, April 9). *Fastest growing occupations.* https://www.bls.gov/emp/tables/fastest-growing-occupations.htm

United States Department of Education. (2004). *NCLB: Executive summary*. http://www.ed.govInc!b/overview /intro/execsumm.html

United States Department of Education. (2018, November 8). *U.S. Department of Education fulfills administration promise to invest $200 million in STEM education* [Press release]. https://www.ed.gov/news/press-releases/us-department-education-fulfills-administration-promise-invest-200-million-stem-education

United States Department of Education, Office of Innovation and Improvement. (2016). *STEM 2026: A vision for innovation in STEM education*. Washington DC: Author. https://innovation.ed.gov/files/2016/09/AIR-STEM2026_Report_2016.pdf

United States Department of Education, National Perkins Reporting System. (2020). *State profiles.* https://cte.ed.gov/profiles/national-summary

Vocational Age Emerges, 1876-1926. (1976). *American Vocational Journal.* https://www.acteonline.org/wp-content/uploads/2018/02/Vocational-Age-Emerges_1876-1926.pdf

Werhan, C. (2013). Family and consumer sciences secondary school programs: National survey shows continued demand for FCS teachers. *Journal of Family and Consumer Sciences*, *105*(4), 41-45. DOI: 10.14307/JFCS105.4.10

Wells, J. G. (2016). PIRPOSAL model of integrative STEM education: Conceptual and pedagogical framework for classroom implementation. https://www.iteea.org/File.aspx?id=87312&v=1ec40a5c

White House, Office of the Press Secretary (2009, November 23). *President Obama launches "Educate to Innovate" campaign for excellence in science, technology, engineering & math (Stem) education.* [Press release]. https://obamawhitehouse.archives.gov/the-press-office/president-obama-launches-educate-innovate-campaign-excellence-science-technology-en

Wu-Rorrer, R. (2017). Filling the gap: Integrating STEM into career and technical education middle school programs: There is no single strategy for approaching STEM integration. (Science, Technology, Engineering, and Math). *Technology and Engineering Teacher, 77*(2), 8. https://www.iteea.org/Publications/Journals/TET.aspx

Zee, M, & Koomen, H.M.Y. (2016). Teacher self-efficacy and its effects on classroom processes, student academic adjustment, and teacher well-being: A synthesis of 40 years of research. *Review of Educational Research*, *86*(4), 981-1015. DOI: 10.3102/0034654315626801

Zollman, A. (2012). Learning for STEM literacy: STEM literacy for learning. *School Science and Mathematics*, *112*(1), 12-19.

# APPENDICES

## APPENDIX A: HUMAN SUBJECTS REVIEW APPROVAL

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| DATE: | May 12, 2022 |
| TO: | Philip Reed |
| FROM: | Old Dominion University Education Human Subjects Review Committee |
| PROJECT TITLE: | [1906584-1] Factors Impacting Family and Consumer Sciences Teachers' Self-Efficacy and Perceptions of STEM Education |
| REFERENCE #: | |
| SUBMISSION TYPE: | New Project |
| ACTION: | DETERMINATION OF EXEMPT STATUS |
| DECISION DATE: | |
| REVIEW CATEGORY: | Exemption category #2 |

Thank you for your submission of New Project materials for this project. The Old Dominion University Education Human Subjects Review Committee has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will retain a copy of this correspondence within our records.

If you have any questions, please contact John Baaki at (757) 683-5491 or jbaaki@odu.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Old Dominion University Education Human Subjects Review Committee's records.

## APPENDIX B: APPROVAL TO USE TEACHER EFFICACY AND ATTITUDES TOWARD STEM (T-STEM) SURVEY

The link and statement below from the Friday Institute for Educational Innovation confirms permission to use *the Teacher Efficacy and Attitudes Toward STEM (T-STEM*) Survey.

> The Friday Institute grants you permission to use these instruments for educational, noncommercial purposes only. You may use an instrument as is, or modify it to suit your needs, but in either case you must credit its original source. By using this instrument you agree to allow the Friday Institute to use the data collected for additional validity and reliability analysis. The Friday Institute will take appropriate measures to maintain the confidentiality of all data (Friday Institute for Educational Innovation, 2012).

https://www.fi.ncsu.edu/resources/teacher-efficacy-and-attitudes-toward-stem-t-stem-survey-elementary-teachers/

# APPENDIX C: TEACHER EFFICACY AND ATTITUDES TOWARD STEM (T-STEM SURVEY

## Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey

Elementary Teacher

*Last Updated October 2012*

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**Appropriate Use**
The Teacher Efficacy and Attitudes Toward STEM (T-STEM) Survey is intended to measure changes in teachers' confidence and self-efficacy in STEM subject content and teaching, use of technology in the classroom, 21st century learning skills, leadership attitudes, and STEM career awareness. The survey is available to help program coordinators make decisions about possible improvements to their program.

The Friday Institute grants you permission to use these instruments for educational, noncommercial purposes only. You may use an instrument as is, or modify it to suit your needs, but in either case you must credit its original source. By using this instrument you agree to allow the Friday Institute to use the data collected for additional validity and reliability analysis. The Friday Institute will take appropriate measures to maintain the confidentiality of all data.

**Recommended citation for this survey:**
Friday Institute for Educational Innovation (2012). *Teacher Efficacy and Attitudes Toward STEM Survey-Elementary Teachers*, Raleigh, NC: Author.

The development of this survey was partially supported by the National Science Foundation under Grant No. 1038154 and by The Golden LEAF Foundation.

The framework for part of this survey was developed from the following sources: Riggs, I. M., & Enochs, L. G. (1990). Toward the development of an elementary teachers science teaching efficacy belief instrument. *Science Education, 74*(6), 625-637. doi: 10.1002/sce.3730740605

MISO
Maximizing the Impact of STEM Outreach
Science, Technology, Engineering and Mathematics

THE WILLIAM & IDA FRIDAY INSTITUTE FOR EDUCATIONAL INNOVATION
NC STATE UNIVERSITY COLLEGE of EDUCATION

Golden LEAF FOUNDATION

This project received support from The Golden LEAF Foundation.

**Science Teaching Outcome Expectancy**

**Directions:** The following questions ask about your feelings about teaching ***in general***. Please respond accordingly.

| | Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort. | ○ | ○ | ○ | ○ | ○ |
| 2. The inadequacy of a student's science background can be overcome by good teaching. | ○ | ○ | ○ | ○ | ○ |
| 3. When a student's learning in science is greater than expected, it is most often due to their teacher having found a more effective teaching approach. | ○ | ○ | ○ | ○ | ○ |
| 4. The teacher is generally responsible for students' learning in science. | ○ | ○ | ○ | ○ | ○ |
| 5. If students' learning in science is less than expected, it is most likely due to ineffective science teaching. | ○ | ○ | ○ | ○ | ○ |
| 6. Students' learning in science is directly realted to their teacher's effectiveness in science teaching. | ○ | ○ | ○ | ○ | ○ |
| 7. When a low achieving child progresses more than expected in science, it is usually due to extra attention given by the teacher. | ○ | ○ | ○ | ○ | ○ |
| 8. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher. | ○ | ○ | ○ | ○ | ○ |
| 9. Minimal student learning in science can generally be attributed to their teachers. | ○ | ○ | ○ | ○ | ○ |

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**DIRECTIONS:**

For each of the following statements, please indicate the degree to which you agree or disagree.

Even though some statements are very similar, please answer each statement. There are no "right" or "wrong" answers. The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help make your choice.

**Science Teaching Efficacy and Beliefs**

**Directions:** Please respond to these questions regarding your feelings about ***your own*** teaching.

| | Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. I am continually improving my science teaching practice. | ○ | ○ | ○ | ○ | ○ |
| 2. I know the steps necessary to teach science effectively. | ○ | ○ | ○ | ○ | ○ |
| 3. I am confident that I can explain to students why science experiments work. | ○ | ○ | ○ | ○ | ○ |
| 4. I am confident that I can teach science effectively. | ○ | ○ | ○ | ○ | ○ |
| 5. I wonder if I have the necessary skills to teach science. | ○ | ○ | ○ | ○ | ○ |
| 6. I understand science concepts well enough to be effective in teaching science. | ○ | ○ | ○ | ○ | ○ |
| 7. Given a choice, I would invite a colleague to evaluate my science teaching. | ○ | ○ | ○ | ○ | ○ |
| 8. I am confident that I can answer students' science questions. | ○ | ○ | ○ | ○ | ○ |
| 9. When a student has difficulty understanding a science concept, I am confident that I know how to help the student understand it better. | ○ | ○ | ○ | ○ | ○ |
| 10. When teaching science, I am confident enough to welcome student questions. | ○ | ○ | ○ | ○ | ○ |
| 11. I know what to do to increase student interest in science. | ○ | ○ | ○ | ○ | ○ |

This project received support from The Golden LEAF Foundation.

**Mathematics Teaching Efficacy and Beliefs**

**Directions:** Please respond to these questions regarding your feelings about ***your own*** teaching.

| | Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. I am continually improving my mathematics teaching practice. | ○ | ○ | ○ | ○ | ○ |
| 2. I know the steps necessary to teach mathematics effectively. | ○ | ○ | ○ | ○ | ○ |
| 3. I am confident that I can explain to students why mathematics experiments work. | ○ | ○ | ○ | ○ | ○ |
| 4. I am confident that I can teach mathematics effectively. | ○ | ○ | ○ | ○ | ○ |
| 5. I wonder if I have the necessary skills to teach mathematics. | ○ | ○ | ○ | ○ | ○ |
| 6. I understand mathematics concepts well enough to be effective in teaching mathematics. | ○ | ○ | ○ | ○ | ○ |
| 7. Given a choice, I would invite a colleague to evaluate my mathematics teaching. | ○ | ○ | ○ | ○ | ○ |
| 8. I am confident that I can answer students' mathematics questions. | ○ | ○ | ○ | ○ | ○ |
| 9. When a student has difficulty understanding a mathematics concept, I am confident that I know how to help the student understand it better. | ○ | ○ | ○ | ○ | ○ |
| 10. When teaching mathematics, I am confident enough to welcome student questions. | ○ | ○ | ○ | ○ | ○ |
| 11. I know what to do to increase student interest in mathematics. | ○ | ○ | ○ | ○ | ○ |

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Golden LEAF FOUNDATION This project received support from The Golden LEAF Foundation.

**Mathematics Teaching Outcome Expectancy**

**Directions:** The following questions ask about your feelings about teaching ***in general***. Please respond accordingly.

| | Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort. | ○ | ○ | ○ | ○ | ○ |
| 2. The inadequacy of a student's mathematics background can be overcome by good teaching. | ○ | ○ | ○ | ○ | ○ |
| 3. When a student's learning in mathematics is greater than expected, it is most often due to their teacher having found a more effective teaching approach. | ○ | ○ | ○ | ○ | ○ |
| 4. The teacher is generally responsible for students' learning in mathematics. | ○ | ○ | ○ | ○ | ○ |
| 5. If students' learning in mathematics is less than expected, it is most likely due to ineffective mathematics teaching. | ○ | ○ | ○ | ○ | ○ |
| 6. Students' learning in mathematics is directly realted to their teacher's effectiveness in mathematics teaching. | ○ | ○ | ○ | ○ | ○ |
| 7. When a low achieving child progresses more than expected in mathematics, it is usually due to extra attention given by the teacher. | ○ | ○ | ○ | ○ | ○ |
| 8. If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher. | ○ | ○ | ○ | ○ | ○ |
| 9. Minimal student learning in mathematics can generally be attributed to their teachers. | ○ | ○ | ○ | ○ | ○ |

This project received support from The Golden LEAF Foundation.

**Student Technology Use**

**Directions:** Please answer the following questions about how often students use technology in settings where you instruct students. If the question is not applicable to your situation, please select "Not Applicable."

**During elementary STEM instructional meetings (e.g. class periods, after school activities, days of summer camp, etc.), how often do your students…**

| | Never | Occasionally | About half the time | Usually | Every time | Not Applicable |
|---|---|---|---|---|---|---|
| 1. Use a variety of technologies, e.g. productivity, data visualization, research, and communication tools. | ○ | ○ | ○ | ○ | ○ | ○ |
| 2. Use technology to communicate and collaborate with others, beyond the classroom. | ○ | ○ | ○ | ○ | ○ | ○ |
| 3. Use technology to access online resources and information as a part of activities. | ○ | ○ | ○ | ○ | ○ | ○ |
| 4. Use the same kinds of tools that professional researchers use, e.g. simulations, databases, satellite imagery. | ○ | ○ | ○ | ○ | ○ | ○ |
| 5. Work on technology-enhanced projects that approach real-world applications of technology. | ○ | ○ | ○ | ○ | ○ | ○ |
| 6. Use technology to help solve problems. | ○ | ○ | ○ | ○ | ○ | ○ |
| 7. Use technology to support higher-order thinking, e.g. analysis, synthesis and evaluation of ideas and information. | ○ | ○ | ○ | ○ | ○ | ○ |
| 8. Use technology to create new ideas and representations of information. | ○ | ○ | ○ | ○ | ○ | ○ |

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The William & Ida Friday Institute for Educational Innovation NC State University College of Education
Golden LEAF Foundation This project received support from The Golden LEAF Foundation.

**Elementary STEM Instruction**

**Directions:** Please answer the following questions about how often students engage in the following tasks during your instructional time.

**During elementary STEM instructional meetings (e.g. class periods, after school activities, days of summer camp, etc.), how often do your students…**

| | Never | Occasionally | About half the time | Usually | Every time |
|---|---|---|---|---|---|
| 1. Develop problem-solving skills through investigations (e.g. scientific, design or theoretical investigations). | ○ | ○ | ○ | ○ | ○ |
| 2. Work in small groups. | ○ | ○ | ○ | ○ | ○ |
| 3. Make predictions that can be tested. | ○ | ○ | ○ | ○ | ○ |
| 4. Make careful observations or measurements. | ○ | ○ | ○ | ○ | ○ |
| 5. Use tools to gather data (e.g. calculators, computers, computer programs, scales, rulers, compasses, etc.). | ○ | ○ | ○ | ○ | ○ |
| 6. Recognize patterns in data. | ○ | ○ | ○ | ○ | ○ |
| 7. Create reasonable explanations of results of an experiment or investigation. | ○ | ○ | ○ | ○ | ○ |
| 8. Choose the most appropriate methods to express results (e.g.drawings, models, charts, graphs, technical language, etc.). | ○ | ○ | ○ | ○ | ○ |
| 9. Complete activities with a real-world context. | ○ | ○ | ○ | ○ | ○ |
| 10. Engage in content-driven dialogue. | ○ | ○ | ○ | ○ | ○ |
| 11. Reason abstractly. | ○ | ○ | ○ | ○ | ○ |
| 12. Reason quantitatively. | ○ | ○ | ○ | ○ | ○ |
| 13. Critique the reasoning of others. | ○ | ○ | ○ | ○ | ○ |
| 14. Learn about careers related to the instructional content. | ○ | ○ | ○ | ○ | ○ |

**21st Century Learning Attitudes**

**Directions:** Please respond to the following questions regarding your feelings about learning ***in general***.

**"I think it is important that students have learning opportunities to…"**

| | Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. Lead others to accomplish a goal. | ○ | ○ | ○ | ○ | ○ |
| 2. Encourage others to do their best. | ○ | ○ | ○ | ○ | ○ |
| 3. Produce high quality work. | ○ | ○ | ○ | ○ | ○ |
| 4. Respect the differences of their peers. | ○ | ○ | ○ | ○ | ○ |
| 5. Help their peers. | ○ | ○ | ○ | ○ | ○ |
| 6. Include others' perspectives when making decisions. | ○ | ○ | ○ | ○ | ○ |
| 7. Make changes when things do not go as planned. | ○ | ○ | ○ | ○ | ○ |
| 8. Set their own learning goals. | ○ | ○ | ○ | ○ | ○ |
| 9. Manage their time wisely when working on their own. | ○ | ○ | ○ | ○ | ○ |
| 10. Choose which assignment out of many needs to be done first. | ○ | ○ | ○ | ○ | ○ |
| 11. Work well with students from different backgrounds. | ○ | ○ | ○ | ○ | ○ |

**APPENDIX D: INVITATION TO PARTICIPANTS**

May 3, 2022

Dear ________________:

You have been identified as a family and consumer sciences (FCS) teacher in the state of Pennsylvania. Your participation is requested in a 20-minute survey that will focus on identifying self-efficacy levels of FCS when teaching science, technology, engineering, and mathematics (STEM) concepts. The survey asks you to rate each item on a Likert-type scale. All involvement will take place online via Google Forms. Your participation in this process will help to shape undergraduate courses in FCS and to equip FCS teachers to integrate STEM into their curriculum.

Though your input would be a valuable contribution to this process, your participation in this study will be totally voluntary. Should you choose to be involved in this study, your identification will remain completely confidential. If you choose to agree to participate, the survey will include basic questions on your professional background. You will be reminded throughout this process that your involvement is completely voluntary and that you can feel free to depart the study at any time. You will receive no direct benefit by participating.

If you decide to contribute your time and input to this study, please complete the survey by May 27, 2022. Please feel free to forward this message to anyone who might be interested. Thank you for your consideration,

Charlene Smith
Ph.D. Candidate

Philip Reed Ph.D.
Education Associate Professor, STEM Education & Professional Studies Old Dominion University

## APPENDIX E: INFORMED CONSENT

### Factors Impacting Family and Consumer Sciences Teachers' Self-efficacy and Perceptions of STEM Education

**Dear Participant:**

You are being asked to participate in dissertation research conducted throughout Pennsylvania. The researchers are:

**Principal Investigator:** Philip A. Reed, PhD
Darden College of Education, Old Dominion University
E-mail: preed@odu.edu

**On-site researcher:** Charlene Smith
Old Dominion University, doctoral candidate
E-mail: csmit081@odu.edu

**Purpose of this consent:**
• to inform you about this project
• to convey to you that participation is voluntary
• to explain potential risks and benefits of participation
• to empower you to make an informed decision about participation
• to record the consent of those who say YES.

Please note that if you are under 18 years old, you are not able to take part in this project.

**Project title: Factors Impacting Family and Consumer Sciences Teachers' Self-efficacy and Perceptions of STEM Education**

**Purpose of project:** As a Family and Consumer Sciences (FCS) teacher in Pennsylvania, you are being asked to participate in a research project that explores factors that impact FCS teachers' self-efficacy and perceptions of STEM education. Your participation will contribute to the knowledge of both student success in STEM and teacher preparation in higher education. This research project has been approved by the Human Subjects Committee (HSC) of Old Dominion University.

**Procedures involving your participation:**
• You will be asked to complete one survey.
• Estimated time to complete all items is 15-20 minutes in one sitting.
• Participation involves completing all items.
• Your participation in this project is completely voluntary.
• It is acceptable for you to say "no".
• Even if you say "yes" now, it is acceptable to say "no" later.
• You may change your mind at any time and withdraw as a participant from this project with no negative consequences.

**Risks and Benefits:**
• Confidentiality of all participants will be protected.
• Responses will be aggregated with other students; individual cases will not be researched.
• Links to your name will be removed.
• Responses will not be linked to other directly identifiable information.
• Marietta College will be anonymized for written descriptions of this research
• As with any research, participants may be subject to risks that have not yet been identified.
• If you say "yes" to participation, your consent in this document does not waive your legal rights.
• You will not receive compensation for participation in this project.
• There are no direct benefits for participation in the project.

**Contact Information for Questions/Concerns:**
If you have any questions about your participation in this project, the researchers listed above are your primary resources.

If you would like to obtain or offer information or register a complaint about this project, you may contact: Philip Reed, PhD, Principal Investigator at preed@odu.edu.

**Voluntary Consent:**

By selection yes below, you are saying several things:
• you have read this form or have had it read to you.
• you understand this form, your participation in this project, and its risks and benefits.
• the researcher has answered any questions you had about the research.

## APPENDIX F: CODING TABLE

| SPSS Name | Variable | Coding Instructions | Measurement Scale |
|---|---|---|---|
| ID | Identification number | Number assigned to each survey | Scale |
| Sex | Sex | 1 = Male, 2 = Female | Nominal |
| Age | Age | Age in years | Scale |
| Educ | Highest level of education completed | 1 = bachelors<br>2 = masters<br>3 = doctorate | Ordinal |
| Years | Number of years teaching | Number in years | Scale |
| Level | Instructional Level I or II teaching Certification | 1 = Instructional Level I<br>2 = Instructional Level II | Nominal |
| FCS | Degree in FCS or Praxis Certified | 1 = Degree in FCS<br>2 = Praxis Certified | Nominal |
| FCCLA | Involved in FCCLA | 1 = Yes<br>2 = No | Nominal |
| STEM | Number of STEM courses taken | Number | Scale |
| SCIEFF | Science Teaching Efficacy and Beliefs | 1 = Strongly Disagree<br>2 = Disagree<br>3 = Neither Agree nor Disagree<br>4 = Agree<br>5 = Strongly Agree | Ordinal |
| SCIOUT | Science Teaching Outcome Expectancy | 1 = Strongly Disagree<br>2 = Disagree<br>3 = Neither Agree nor Disagree<br>4 = Agree<br>5 = Strongly Agree | Ordinal |
| MATHEFF | Mathematics Teaching Efficacy and Beliefs | 1 = Strongly Disagree<br>2 = Disagree<br>3 = Neither Agree nor Disagree<br>4 = Agree<br>5 = Strongly Agree | Ordinal |
| MATHOUT | Mathematics Teaching Outcome Expectancy | 1 = Strongly Disagree<br>2 = Disagree<br>3 = Neither Agree nor Disagree<br>4 = Agree<br>5 = Strongly Agree | Ordinal |
| TECHUSE | Student Technology Use | 1 = Never<br>2 = Occasionally<br>3 = About half the time<br>4 = Usually<br>5 = Every time | Ordinal |
| STEMINST | STEM Instruction | 1 = Never<br>2 = Occasionally | Ordinal |

| | | | |
|---|---|---|---|
| | | 3 = About half the time<br>4 = Usually<br>5 = Every time | |
| TWELEAR | 21st Century Learning Attitudes | 1 = Strongly Disagree<br>2 = Disagree<br>3 = Neither Agree nor Disagree<br>4 = Agree<br>5 = Strongly Agree | Ordinal |

# VITA


## Charlene Wirfel Smith

**Old Dominion University, Department of STEM Education & Professional Studies**
**4101-A Education Building, Norfolk, VA 23529**
**814-248-2869 ~ csmit081@odu.edu**


### Academic Degrees

- Ph.D. Education, Old Dominion University *(December 2022)*
- STEM Endorsement, Millersville University (*2018)*
- M.S. Nutrition Education, American University (*2017)*
- B.S. Family and Consumer Sciences Education, Indiana University of Pennsylvania (*2006)*

### Professional and Leadership Experience

- Executive Board for Pennsylvania Association of Family and Consumer Sciences *(2022)*
- Awards juror for American Association of Family and Consumer Sciences *(2022)*
- Conference proposal reviewer for American Association of Family and Consumer Sciences *(2020-present)*
- Family and Consumer Sciences Teacher, Hempfield High School, Hempfield School District, Landisville, PA *(January 2019 – present)*
- Family and Consumer Sciences Teacher, Manheim Township High School, Manheim Township School District, Lancaster, PA *(August 2008 - January 2019)*
- Family and Consumer Sciences Teacher, South River High School, Anne Arundel County Public Schools, Edgewater, MD *(July 2006 - August 2008)*

### Awards

- ACTER conference presentation, awarded best round table presentation *(2022)*
- Jewell Taylor Fellowship, American Association of Family and Consumer Sciences, *2021*
- Graduate Student Travel Award, Old Dominion University *(2021)*
- Family and Consumer Sciences Fellowship, Association for Career and Technical Education (*2019)*
- Nutrition Education Merit Scholarship, American University (*2015)*
- Longenecker Scholarship, Indiana University of Pennsylvania (*2005, 2006)*