VIRTUAL MENTORING IN AGRICULTURAL EDUCATION: DESCRIBING DIGITAL LITERACY, TECHNOLOGY SELF-EFFICACY, AND ATTITUDES TOWARDS TECHNOLOGY OF PRE-SERVICE AND IN-SERVICE AGRICULTURAL EDUCATORS

A Dissertation in
Agricultural and Extension Education

by
Tiffany Morey

© 2020 Tiffany Morey

Submitted in Partial Fulfillment of the Requirements for the Degree of

Doctorate of Philosophy

August 2020
The dissertation of Tiffany G. Morey was reviewed and approved by the following:

Daniel D. Foster
Associate Professor of Agricultural and Extension Education
Dissertation Adviser
Chair of Committee

John C. Ewing
Associate Professor of Agricultural and Extension Education

Anil Kumar Chaudhary
Assistant Professor of Agricultural and Extension Education

Heather Zimmerman
Associate Professor of Learning Design and Technology

Mark Brennan
Director of Graduate Studies, Agricultural and Extension Education
ABSTRACT

Digital literacy, technology self-efficacy, and attitude toward technology play an impactful role in the life of pre-service and in-service agriculture teachers. Proficiency in digital literacy and technology self-efficacy, along with a positive attitude toward technology, can predict and shape an educator's capacity to implement best practices for teaching and learning with technology. The study examined the effects of participation in a virtual mentoring program on the digital literacy, technology self-efficacy, and attitude toward technology of pre-service and in-service agriculture teachers, and investigated if there is a relationship between virtual mentoring program participation and Twitter, blogging, and video observation usage of pre-service and in-service agriculture teachers. We found that in-service agriculture teachers who had participated in a virtual mentoring program exhibited higher overall digital literacy levels and technology self-efficacy levels than those in-service agriculture teachers who had not participated in a virtual mentoring program. We also discovered that virtual mentoring program participation impacted the utilization of Twitter, blogging, and video observation for pre-service agriculture teachers, as well as a relationship between virtual mentoring participation and blogging usage for in-service teachers. Pragmatic implications include a defined opportunity for agriculture teacher educators and agricultural education leaders to develop appropriate and beneficial tools and materials to assist pre-service and in-service agriculture teachers in developing digital literacy skills and technology self-efficacy skills, and a positive attitude toward technology. Recommendations for future research include examining relationships of intensity of utilization of the technology platforms (Twitter, blogging, and video observation) with an educators' digital literacy, technology self-efficacy, and attitude toward technology.
# TABLE OF CONTENTS

LIST OF TABLES .......................................................................................................................... v
LIST OF FIGURES .......................................................................................................................... vii
ACKNOWLEDGEMENTS .................................................................................................................. viii

CHAPTER 1 INTRODUCTION ....................................................................................................... 1

Introduction ................................................................................................................................. 1
Purpose and Objectives .............................................................................................................. 7
Operational Definitions ............................................................................................................. 8
Assumptions ............................................................................................................................... 10
Limitations ................................................................................................................................. 11
Summary .................................................................................................................................... 12

CHAPTER 2 REVIEW OF LITERATURE ....................................................................................... 13

Purpose and Objectives .............................................................................................................. 13
Study Terms, Variables of Interest, and Theoretical Models ..................................................... 14
  Mentoring ............................................................................................................................... 15
  Communities of Practice ....................................................................................................... 20
  Online Professional Learning Communities ....................................................................... 22
  Digital Ecosystem .................................................................................................................... 28
  PCK, TPACK, and TPACK-Deep ............................................................................................ 32
  Digital Literacy ....................................................................................................................... 36
  Digital Technology Self-Efficacy ............................................................................................ 39
  Attitude Toward Technology ................................................................................................. 42
Conceptual Model .................................................................................................................... 45
Summary .................................................................................................................................... 48

CHAPTER 3 METHODS ............................................................................................................... 49

Research Perspective and Research Design ............................................................................. 49
Purpose and Objectives .............................................................................................................. 51
Explanation of Study Framework and Methodology ................................................................. 53
Study Population Selection ...................................................................................................... 54
Survey Instrument Development .............................................................................................. 56
Instrument Error, Reliability, and Validity ................................................................................ 59
Coverage Error ........................................................................................................................ 59
Summary

Findings for Research Objective 7

Findings for Research Objective 6

Findings for Research Objective 5

Findings for Research Objective 4

Findings for Research Objective 3

Findings for Research Objective 2

Findings for Research Objective 1

Demographic Characteristics of Study Participants

Data Analysis

CHAPTER 4 RESULTS

Purpose and Objectives

Data Analysis

Demographic Characteristics of Study Participants

Findings for Research Objective 1

Summary of Descriptive Statistics

Independent Sample T-Test Results

Findings for Research Objective 2

Summary of Descriptive Statistics

Independent Sample T-Test Results

Findings for Research Objective 3

Summary of Descriptive Statistics

Independent Sample T-Test Results

Findings for Research Objective 4

Summary of Descriptive Statistics

Independent Sample T-Test Results

Findings for Research Objective 5

Summary of Descriptive Statistics

Independent Sample T-Test

Findings for Research Objective 6

Summary of Descriptive Statistics

Independent Sample T-Test Results

Findings for Research Objective 7

Pre-Service Teachers

In-Service Teachers

Summary

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS
LIST OF TABLES

Table 1  Summary of Survey Participants ................................................................. 56
Table 2  Examples of Statements from Digital Literacy Instrument ............................ 57
Table 3  Examples of Statements from Technology Self-Efficacy Instrument .................. 58
Table 4  Examples of Statements from Attitude Toward Technology Instrument ............... 59
Table 5  Independent Sample t-Test Results for Response Time and Overall Technology Behavior Score ................................................................. 62
Table 6  Reliability of Survey Instrument Components: Pre-Service Teachers ................. 64
Table 7  Reliability of Survey Instrument Components: In-Service Teachers .................. 65
Table 8  Original In-Service Agriculture Teacher Survey Instrument Administration Timeline. 70
Table 9  Revised In-Service Agriculture Teacher Survey Instrument Administration Timeline .. 71
Table 10  Pre-Service Agriculture Teacher Survey Instrument Administration Timeline .......... 73
Table 11  Data Analysis Coding System ......................................................................... 74
Table 12  Summary of Data Analysis of Research Objectives ......................................... 77
Table 13  Summary of Survey Response Rates ................................................................ 81
Table 14  Summary of Demographic Variables: Overall Study Participants ..................... 82
Table 15  Summary of Demographic Variables: Pre-Service Agriculture Teachers ............. 83
Table 16  Summary of Demographic Variables: In-Service Teachers ............................... 84
Table 17  Pre-Service Agriculture Teacher Means and Standard Deviations of Digital Literacy Items ........................................................................................................ 86
Table 18  In-Service Agriculture Teacher Means and Standard Deviations of Digital Literacy Items ........................................................................................................ 89
Table 19 Pre-Service Agriculture Teacher Means and Standard Deviations of Technology Self-Efficacy Items ........................................................................................................................................ 92

Table 20 In-Service Agriculture Teacher Means and Standard Deviations of Technology Self-Efficacy Items ........................................................................................................................................ 96

Table 21 Pre-Service Agriculture Teacher Means and Standard Deviations of Attitude Toward Technology Items ........................................................................................................................................ 100

Table 22 In-Service Agriculture Teacher Means and Standard Deviations of Attitude Toward Technology Items ........................................................................................................................................ 103
LIST OF FIGURES

Figure 1 Anderson and Shannon’s (1988) Mentoring Cycle .......................................................... 19

Figure 2 C4P Framework (Hoadley & Kilmer, 2015) ................................................................. 24

Figure 3 Social Media-Based Online Professional Learning Communities (Xue et al., 2019) ... 27

Figure 4 Pedagogy Content Knowledge (PCK) Model (Shulman, 1986, 1987) ......................... 33

Figure 5 Technological, Pedagogical, and Content Knowledge (TPACK) Model (Kohler & Misra, 2009) .................................................................................................................... 34

Figure 6 TPACK-Deep Model (Kabacki et al., 2004) ................................................................. 35

Figure 7 Factors Influencing Digital Literacy (Ng, 2012) ................................................................ 37

Figure 8 Conceptual Model for the Influence of Technology on Elements of Virtual Mentoring (Morey, 2020) ........................................................................................................... 45

Figure 9 Study Methods Model (Morey, 2020) ............................................................................. 53

Figure 10 Summary of Study Findings .......................................................................................... 110

Figure 11 Conceptual Model for Future Study on Virtual Mentoring, Digital Communication Platforms, and TPACK Behaviors (Morey, 2020) ................................................................. 136
ACKNOWLEDGEMENTS

Thank you to the Pennsylvania Department of Education and the Center for Professional Personnel Development at The Pennsylvania State University for supplying the funding for the graduate assistantship that made completing this Ph.D. and conducting the research that supported this dissertation study possible. It has been a privilege to assist and work with the in-service and pre-service agriculture teachers in Pennsylvania.
CHAPTER 1
INTRODUCTION

Chapter one presents background information contributing to problem statement development, as well as the purpose statement, research questions, and conceptual model that guides the study. In addition, Chapter one reviews the study's operational definitions and limitations of the study.

Introduction

“Rapidly evolving technology has not only fundamentally changed the way in which we live, work and communicate, but also revolutionized the education system” (Li, Worsh, Zhou, & Aguiton, 2015, p. 1). Fundamental changes in the work and education systems have brought to light the disconnect between needed skills and teacher capacity, creating a need for in-service and pre-service teachers to have the knowledge, skills and strategies to effectively integrate educational technology tools and platforms into their teaching and learning practices (Stobaugh & Tassell, 2011). The changes in the education system have also exposed the growing gap between required classroom practices in the 21st century and teachers’ use of digital technologies (Ata & Yıldırım, 2019).

The need for teachers to have the tools to integrate technology into their classroom practices and teaching and learning behaviors was emphasized in Spring 2020 when the COVID-19 pandemic disrupted education in the United States (Lieberman, 2020). What began as
temporary, short-term cancellations for some school districts expanded into the closure of schools in all 50 states for the duration of the academic year with educators being asked to continue providing academic instruction and support to students via virtual instruction. The transition often came with little or no time for additional professional development to help prepare educators (Tatum, 2020), as they were tasked with finding ways to implement online education best practices with their students.

In-service teachers at all stages of their careers faced additional challenges of finding and learning different course management and delivery platforms, determining which digital media creation tools to use to deliver their content, how to connect with students for one-on-one instruction, group, or office hour communication, and how to digitally assess student work and understanding (Herold, 2020). Teachers were also tasked with using what technology hardware, software, and applications their school districts provided them (Lieberman, 2020). If that were not enough, whatever instructional activities and materials they created also had to be accessible for students with a wide range of devices and internet access.

The successful integration of technology into teaching and learning practices, and the development of pedagogical practices for teaching and learning with technology does not happen overnight; it is something that develops over time and with practice (Li et al., 2015). An educator's individual digital literacy, technology self-efficacy, and attitude toward technology impacts their capacity and behaviors towards the utilization of technology. These behaviors affect a teacher’s ability to meaningfully transfer skills between personal and professional use, including purposeful integration into teaching and learning experiences (Lemon & Garvis, 2016).

“If classroom teachers are to meet the need for meaningful integration of technology in educational settings, there must be a restructuring of both teacher preparation programs and
current classroom practice” (Murphy, Richards, Lewis, & Carman, 2005, p 125). There has been a consistent call in teacher education for pre-service teachers to be conversant in 21st century skills such as the ability to use digital technologies for pedagogical purposes (Bullock, 2003). Teacher educators are being asked to integrate these behaviors into pre-service teacher coursework in ways that are meaningful and will translate effectively into teaching and learning practices in the classroom (Nascimento & Knobel, 2017).

The vital need for the integration of digital literacy: being able to select the correct form of technology to use for the appropriate and intended purpose; technology self-efficacy: having the knowledge and skills to properly use technology for the appropriate and intended purpose; and attitude toward technology: how one feels about using technology for a specific purpose, into teacher preparation programs were also brought to light during the COVID-19 pandemic. The closure of schools not only impacted in-service teachers, but also pre-service teachers who were completing their student teaching internships (K.Curry, personal communication, April 2020). Pre-service teachers were challenged to not only learn new instructional techniques and pedagogical practices for the traditional classroom, but techniques and practices for the virtual classroom as well (Tatum, 2020). Pre-service teachers also had to find a way to use technology to communicate with their students and cooperating teacher, and to continue to teach the material needed for them to fulfill their internship requirements.

When teachers have high levels of digital literacy, technology self-efficacy, and a positive attitude towards technology, they may find it easier to use technology in their teaching and learning practices (Joo, Park, & Lim, 2018). High levels of digital literacy and technology self-efficacy accompanied by a positive attitude toward technology can also help teachers to perceive technology as a helpful teaching tool. Providing a series of trainings or workshops
centered on digital literacy, technology self-efficacy, and attitude toward technology is one way to assist teachers in improving each of the three behaviors. Trainings or workshops can be tailored to individual abilities and comfort levels of teaching and learning with technology by identifying criteria for digital literacy, technology self-efficacy, and attitudes towards technology. Activities that are designed to help teachers overcome their reluctance to learn about new technology and to help to enable them to perceive the ease of use and usefulness of technology would be implemented (Joo et al., 2018).

Teachers benefit from support to scaffold the use of classroom technology in the field and to increase their access to classroom technology (Li et al., 2015). Such support can help teachers to increase their integration of technology into teaching and learning practices, develop digital literacy and technology self-efficacy skills, and maintain a positive attitude toward technology. An example of a type of support that can be used to assist teachers with technology integration is participation in an online professional learning community. In these communities, teachers are able to be matched with other teachers who are familiar with their content area and educational technology usage needs and who can provide them with support and guidance (Li et al., 2015).

Online professional learning communities serve as professional development resources that provide targeted support for pre-service teachers as they begin to implement educational technology in their classrooms. In-service teachers are able to use online professional learning communities to provide suggestions and ideas for how to implement appropriate classroom technology to meet the needs of pre-service teachers as they develop teaching and learning practices utilizing technology. Implementing the usage of online professional learning communities before student teaching internships can be especially beneficial. With the guidance
of virtual mentors and classroom mentor teachers, pre-service teachers can appropriately prioritize attention to the technology aspects of teaching and learning (Liu, 2012).

An online professional learning community can be hosted on platforms using social media, blogging, or video observation. Differences between participants in professional learning communities who experience mentoring in the same physical location and those who experience mentoring virtually can include a greater reliance on speaking and listening on the part of both the mentor and the mentee. Virtual mentoring increases the likelihood that the mentor and mentee may not be familiar with each other’s contexts, requiring the use of technology and digital communication skills to promote authentic relationship-building (Owen, 2015). The use of an online professional learning community can give mentors and mentees an easily-accessible space in which participants can ask advice, discuss theory and practice, share resources and knowledge, offer practical assistance, and reflect, think and process about teaching and learning practices. Additional benefits of virtual mentoring include giving and receiving feedback, decreased feelings of isolation, increased feelings of resilience, and the development of greater technology self-efficacy (Owen, 2015).

Based on the importance of the development of technology usage behaviors and digital communication skills, The Pennsylvania State University Agriculture Teacher Education Program established a formal virtual mentoring program to create digital support teams for pre-service agricultural educators in the 2017-2018 academic year. With the intent of establishing online professional learning communities, each pre-service teacher in their final year of the agriculture teacher preparation program was provided with their own unique virtual mentoring team comprised of five individuals: their assigned cooperating teacher, a recent program graduate, an in-state agricultural educator, an out-of-state agricultural educator, and the
university supervisor. Virtual mentors volunteered and were not compensated for their time or participation. Reese’s (2016) recommendations to provide virtual mentors with the technical support and training they need to engage in a virtual mentoring program were followed. Virtual mentoring teams met via a video conferencing platform prior to the start of the virtual mentoring program. During this orientation meeting, the virtual mentoring program coordinator reviewed norms and procedures for virtual mentoring, while providing a digital virtual mentoring handbook outlining roles, responsibilities, and technology best practices.

Based on prior research of pre-service teacher technology needs and best practices for establishing online professional learning communities, virtual mentoring teams used social media, blogging, and video observation as the primary platforms for communication with one another (Liu, Tsai, & Huang, 2015; Paulsen, Anderson, & Tweeten, 2015; Wenger, 2007). The specific platforms chosen for each type of digital communication tool were Twitter, a social media application; Edthena, a video observation feedback website; and Blogger, an online blogging tool. Twitter and Blogger are commonly used for educational purposes and are free (Risser, 2013; Williams & Jacobs, 2004). Edthena is a paid, subscription-based platform. Edthena was chosen because of its feedback features, ability to link videos to specific educational frameworks and standards, and security features including password protection to access videos.

Prior researchers (Ebner, Lienhardt, Rohs, & Meyer, 2010; Reese, 2016; Williams & Jacobs, 2004) reported that using the digital communication platforms (Twitter, Blogger, and Edthena) could help teachers become more tech savvy and that participation in virtual mentoring using one specific means or channel could be beneficial (Owen, 2015). Previous research (Reese, 2016) had also been conducted on pre-service teachers’ perceptions of a virtual mentoring
program and how technology usage during the teacher preparation process impacted their digital literacy, technology self-efficacy, and attitude towards technology (Joo et al, 2018; Li et al, 2015). The effects of a combination of platforms and their impact on digital literacy, technology self-efficacy, and attitude toward technology of both pre-service and in-service teachers was not readily found in the literature. Research was lacking on mentor teachers’ perceptions of their experiences as virtual mentors of pre-service teachers and how using technology in mentoring impacts digital literacy, technology self-efficacy, and attitude towards technology.

**Purpose and Objectives**

The purpose of the study was to describe the impact of virtual mentoring program participation on digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication for pre-service agricultural teacher candidates and in-service agricultural educators. The following research objectives guided the study:

1. Describe the digital literacy of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.
2. Describe the digital literacy of in-service agriculture teachers from different states who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.
3. Describe the digital technology self-efficacy of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated...
in a virtual mentoring program using the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument.

4. Describe the digital technology self-efficacy of in-service agriculture teachers from different states who have and have not participated in a virtual mentoring program using the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument.

5. Describe the attitudes towards digital communication of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using Aydin and Karaa’s (2013) Attitudes Toward Technology instrument.

6. Describe the attitudes towards digital communication of in-service agriculture teachers from different states who have and have not participated in a virtual mentoring program using Aydin and Karaa’s (2013) Attitudes Toward Technology instrument.

7. Compare Twitter usage, blogging usage, and video observation usage of pre-service agriculture teacher and in-service agriculture teacher populations who have and have not participated in a virtual mentoring program.

Operational Definitions

- **Attitudes towards digital technology**: the beliefs held, and experiences had by individuals which contribute to their use of technology. The construct that names, defines, and describes the structure and content of the mental states that are thought to drive a person's actions and that are expected to predict one's uses of technology (Bai & Ertner, 2008).
• **Community of practice**: the physical space in which educators converse and share resources for teaching pedagogy and practice. A group of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis (Wenger, McDermott, & Snyder, 2002).

• **Online Learning Community**: the virtual space in which educators converse and share resources for teaching pedagogy and practice. Digital communication and resource sharing spaces facilitated by online social networks, such as Twitter (Gunawardena, Hermans, Sanchez, Richmond, Bohley, & Tuttle, 2009).

• **Digital ecosystem**: a group of people with a similar interest that communicate for a specific purpose using established digital communication platforms. An interdependent group of people that share an established group of digital platforms for a mutually beneficial purpose, such as a common interest; based off of the adaptive and sustainable processes from natural ecosystems (Briscoe, Sadedin, & De Wilde, 2011).

• **Digital literacy**: having the technical ability to use technology to improve teaching through the use of multiple platforms and tools for instruction and professional communication. The awareness, attitude, and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyze, and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action (Koltay, Špiranec, & Karvalics, 2015).

• **Digital technology self-efficacy**: the self-assessment of one’s capabilities to use certain forms of digital communication technology. Self-assessment of a person’s capabilities to attain a desired level of performance in a given endeavor (Bandura, 1986).

• **Mentoring**: the formal and informal interactions between mentors and mentees centered on personal, professional, and pedagogical topics. The complex social interactions in which mentor
teachers and pre-service teachers construct and negotiate for various professional purposes and in response to contextual factors (Fairbanks, Freedman, & Kahn, 2000).

- **Virtual mentoring**: mentoring carried out in a digital space and through digital communication as opposed to face-to-face.

- **Virtual mentoring team**: A team comprising the pre-service agriculture teacher, cooperating teacher, recent program graduate mentor, in-state agriculture teacher mentor, out-of-state agriculture teacher mentor that work together using digital communication to support the pre-service agriculture teacher during their final year of studies and the student teaching internship.

**Assumptions**

The following assumptions were identified for this study:

1. The researcher adopted a positive paradigm using a quantitative approach that assumes that reality exists and can be observed and revealed by using empirical and logical approach and analysis (Cresswell, 2013).

2. The instrument developed by the researcher was valid and reliable.

3. Participants were willing to complete the instrument as well as provide genuine responses to the questions on the questionnaire.

4. Participants were willing to provide information that accurately reflected their thoughts and perspectives regarding their digital literacy, technology self-efficacy, and attitude toward technology.

5. The study was conducted objectively.
6. The study was in compliance with the IRB guidelines at The Pennsylvania State University.

7. Data analysis and interpretation were conducted in an objective manner and the researcher remained objective for this study during data interpretation and analysis.

8. The researcher was aware of different types of biases in social science and efforts were made to minimize these potential biases.

**Limitations**

Limitations of the study include self-reported data and small populations of survey participants. Self-reported data may not be as accurate as data collected by an external evaluator. Self-reported data can lead to exaggerated reporting of responses on the survey instrument.

The number of participants in the virtual mentoring program was small when compared to similar populations of in-service agricultural educators. The in-service agriculture teacher participants who had not participated in the virtual mentoring program were all from the state of Pennsylvania, home to The Pennsylvania State University where the virtual mentoring program is conducted. These teachers may have had prior knowledge of the virtual mentoring program and its functions or may teach with a colleague who has participated in the virtual mentoring program. The number of pre-service agriculture teachers enrolled at The Pennsylvania State University is relatively small, and all study participants from this population were aware of the virtual mentoring program whether they had participated in it or not.
Summary

In chapter one, the research study was described with a presentation of prior, background research that supported the study topic selection including a brief summary of studies that describe the increased usage of technology in the classroom. Upon identification of the problem being studied, the purpose and objectives of the study were presented. The three technology behaviors of interest: digital literacy, technology self-efficacy, and attitude toward technology were described. Chapter one included documentation of critical operational definitions of terms utilized in the study. Finally, the assumptions and limitations were described, as were potential impacts on study findings.
CHAPTER 2
REVIEW OF LITERATURE

Chapter two describes the different elements that influenced the development of the virtual mentoring program. Chapter two begins with the purpose and objectives of the study, guiding a discussion of the terms and variables used throughout the study. Included in this discussion is previous research related to each variable along with a description of the related influential theoretical framework. Chapter two concludes with a description of the conceptual model that guided the study.

Purpose and Objectives

The purpose of the study is to describe the impact of virtual mentoring program participation on digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication for pre-service agricultural teacher candidates and in-service agricultural educators. The following research objectives guide the study:

1. Describe the digital literacy of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.

2. Describe the digital literacy of in-service agriculture teachers from different states who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.
3. Describe the digital technology self-efficacy of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument.

4. Describe the digital technology self-efficacy of in-service agriculture teachers from different states who have and have not participated in a virtual mentoring program using the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument.

5. Describe the attitudes towards digital communication of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using Aydin and Karaa’s (2013) Attitudes Toward Technology instrument.

6. Describe the attitudes towards digital communication of in-service agriculture teachers from different states who have and have not participated in a virtual mentoring program using Aydin and Karaa’s (2013) Attitudes Toward Technology instrument.

7. Compare Twitter usage, blogging usage, and video observation usage of pre-service agriculture teacher and in-service agriculture teacher populations who have and have not participated in a virtual mentoring program.

**Study Terms, Variables of Interest, and Theoretical Models**

In this section, the themes of how technology has impacted mentoring, communities of practice, and teaching and learning behaviors will be presented. Findings from previous studies that
support the rationale for the research being conducted for the study will be discussed. Theoretical models will accompany the analysis of the literature.

Mentoring

Mentoring has long been a part of successful educational programs regardless of discipline to help students navigate from classes to careers. Participating in a mentoring community affords pre-service teachers the time and place to be in conversation with others who are holding their well-being at heart, who have no vested interest other than contributing to their success, and who help to create a place of safety where mentees find acceptance and are listened to. Successful mentoring relationships are built around the tenants of role modeling, nurturing, and caring, with mentors and mentees engaging in experiences that promote teaching, sponsorship, encouragement, counseling, and friendship (Anderson & Shannon, 1988).

Traditional mentoring programs in teacher education involve face-to-face interaction where mentors and mentees communicate in person. Fairbanks, Freedman and Kahn (2000) define mentoring in teacher preparation programs as the complex social interactions in which mentor teachers and pre-service teachers construct and negotiate for various professional purposes and in response to contextual factors. Through these interactions, pre-service teachers and mentors learn from each other, and improve their ability to identify and explain their teaching practices, see Figure 1. Meaningful and collaborative relationships between pre-service teachers and mentors allow for focused dialogue on teaching and learning (Liu et al., 2015). Conway and Holcomb (2008) found that mentorship is an important form of professional development that can contribute positively to pre-service teachers’ current and future success and
that the most meaningful types of mentorship occur through observations by, feedback from, and interactions with experienced teachers who serve as mentors. Benefits of mentoring for experienced teachers include increased enthusiasm for teaching and learning, feelings of self-fulfillment, and the development of leadership skills. Mentoring also gives experienced teachers the opportunity to learn as they critique, reflect on, and adopt new teaching practices from their mentees (Hudson, 2010).

The field of agricultural education is unique in the fact that it has often been referred to as a family, where professionals work together to help one another. It is not uncommon to see more experienced teachers take those new to the profession under their wing and serve as mentors, or to see those already in the classroom collaborate to address challenges and innovations that affect the profession. Teachers have named these things, along with the importance of contributing to the improvement of the teaching profession as some of the reasons why they choose to become mentors (Zeek, Foote, & Walker, 2001).

There is currently no formalized mentoring program for agricultural education, and agricultural educators engage in these practices on their own time and of their own volition. While some teachers are able to meet, mentor, and work together in-person to engage in communities of practice, not all are able to participate in this type of mentoring relationship. When geographical separation comes into play, virtual mentoring can serve as a way for mentors and mentees to communicate and engage with one another. Teachers have reported that engaging in both in-person and virtual mentoring decrease feelings of isolation and increases effectiveness in teaching and learning practices (Juarez-Torres, Hurst, & Hurst, 2007).

Engaging in a virtual mentoring program offers mentors valuable time to interact meaningfully with pre-service teachers, opportunities to contribute to pre-service teachers’
development without the pressures they associated with having a student teacher, and a chance to
develop teaching and mentoring skills to be successful mentors in the future (Reese, 2015). The
experience offers mentees the chance to participate in a virtual community of mentoring and
practice with agricultural educators from a wide variety of backgrounds who share an interest in
professional development and who can foster shared wisdom and operational knowledge
(Carney, Dolan, & Seagle, 2015). Virtual mentoring is portable, which allows mentors and
mentees to continue to work together if they change location or context, allows for tailored
participation to suit the needs of mentors and mentees, is flexible in terms of timing for
participation, and is cost-effective because there are no travel or coverage expenses required for
mentors and mentees to meet (Owen, 2015).

Having a mentor in a different region, institution, or area of practice encourages a mentee
to consider alternative viewpoints and ways to accomplish tasks (Lewis & Flannery, 2016). It
allows mentors and mentees to cross geographical boundaries to communicate and engage in
professional relationships with one another. Virtual mentoring can offer valuable professional
development opportunities for experienced teachers whose geographic location makes on-site
field experiences and face-to-face mentoring difficult (Reese, 2016).

Virtual mentoring also provides both parties with the opportunity to learn about teaching
and learning practices in other locations and can link them with new resources and ideas for
teaching content and working with students. Virtual mentoring can create opportunities for cross-
cultural mentoring experiences, increase opportunities for interactions with other teachers, and
reduce feelings of isolation (Reese, 2016). It can also benefit pre-service and experienced
teachers by providing perspectives on education in other cultural settings.
However, not every mentor may be able to transition to virtual mentorship. Mentors who have had less experience with technology or who do not have adequate technological support can struggle in a way that may impede their participation in a virtual mentoring program or their ability to successfully provide virtual mentorship (Reese, 2016). Other mentors may teach in school districts where they do not have the adequate technical support or technology to participate as a virtual mentor. To prevent these things from occurring, Reese (2016) recommends providing virtual mentors with the technical support and equipment that they need to communicate and engage in a virtual mentoring program.

The framework for virtual mentoring and its functions and processes is also rooted in Anderson and Shannon’s mentoring cycle framework presented in Figure 1. Their work found that mentoring is not a linear process but is a circle of a continuous series of behaviors and events centered on the tenants of mentoring relationships, functions of mentoring, and mentoring activities. Throughout the mentoring process, mentors and mentees take turns leading, expressing care and concern, and opening up to one another.
In a study of virtual mentoring in New Zealand, Owen (2015) found that even though the virtual mentoring relationships were slower to develop than traditional mentoring relationships, trust formed between virtual mentors and mentees. The building of trust occurred because mentors and mentees were less able to make assumptions based on demographics, and environmental features such as the room and furniture. Mentees also found the virtual environment a more comfortable medium to candidly share their thoughts, ideas and observations and described it as a place where they felt more comfortable about being honest about what they were experiencing. Mentees reported that when they encountered challenges, being able to communicate with their virtual mentor made a difference because their mentor was able to support them when they encountered barriers, channel their thinking in new directions, provide encouragement, and helped them network with others in the profession who may also be able to provide support.
The findings of Owen’s (2015) study demonstrate how virtual mentoring recreates crucial aspects of the mentoring process through the use of digital technology. By utilizing carefully chosen communication platforms, mentors and mentees are able to engage in the functions of mentoring and build authentic mentoring relationships. Using a combination of digital communication platforms provides a unique virtual environment that fosters and promotes a virtual mentoring community that is similar to a traditional community of practice.

Communities of Practice

Mentoring relationships in education have traditionally been conducted through the usage of communities of practice. A community of practice (CoP) describes a group of people “who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis” (Wenger et al., 2002). Hibbert and Rich (2006) recommend that CoPs should be designed to ‘support the actual practices and daily tasks of the participants’ (p. 564). Goodyear, Casey, and Kirk (2014) suggest that the interactions among participants in a CoP should be conducted in ways that are meaningful, mutually beneficial, sustained, and influential.

Wenger (2007) states that CoPs exist for several different reasons: to help people solve every day work problems in their discipline, to develop and disseminate a set of best practices, to develop and steward the tools, insights, and approaches needed by individuals in a certain field, and to develop highly innovative solutions and ideas. All of these apply to education, where teachers used communities of practice as a way to gain resources needed to improve their
instructional practices, navigate the daily challenges of working with students, and to create new and interesting learning activities and artifacts.

A CoP defines itself along three dimensions: what it is about-the domain, how it functions-the community, and what capability it has produced-the practice (Wenger, 2007). Wenger et al. (2002) note that when these three elements function well together, they make a CoP an ideal "knowledge structure – a social structure that can assume responsibility for developing and sharing knowledge" (p. 29). This supports the function of mentoring well, as the mentoring relationship not only shares knowledge, but helps individuals develop the skills and resources needed for future success in a profession.

In a community of practice, the domain represents common ground where participants share their ideas, knowledge, and stories. The domain can be an actual, physical space, or on created online in the digital world. As participants engage in the domain, a shared understanding can develop, which fosters the beginning stages of a sense of community. Hibbert and Rich (2006) found that knowledge is not borrowed from the community of practice but is constructed through meaningful interactions with community members that are informed by personal and social experience. As the sense of community strengthens, communication within the domain creates personal meaning and strategic relevance for participants (Wenger et al., 2002).

The community within a CoP is a group of people who learn and interact together, build relationships, and established the feeling of belonging and mutual commitment through their communication and interactions (Wenger, 2007). Maloney and Konza (2011) outlined five features of a good professional learning community: ‘supportive and shared leadership, shared values and vision, collective learning and application of that learning, shared learning practice, and supportive conditions for the maintenance of the learning community’ (p. 77). How these
features occur can take on a variety of forms. It can occur in person through traditional communities of practice, or online through online professional learning communities.

Through these interactions the community works to develop the practice, which is the nature of the tool that mediates communication impacts (Wenger, 2007). It also can alter members’ perceptions of the communication process and can influence how they perceive their social roles. Hibbert and Rich (2006) found that knowledge is not borrowed from the community of practice but is constructed through meaningful interactions with community members that are informed by personal and social experience. A good relationship among the members of a community of practice can also lead to a strong sense of community that affects the participants’ commitment to continued engagement in the community of practice (Tang & Lam, 2014).

*Online Professional Learning Communities*

As the use of digital communication has become more common, traditional CoPs have evolved into online professional learning communities. An online professional learning community can be defined as a group of people, who share and develop knowledge, beliefs, values and experiences focused on a common practice through regular interactions facilitated by technologically mediated communications (Liu, 2012). A 2010 study by Ebner, Lienhardt, Rohs, and Meyer found that online professional learning communities had great potential to expand teaching and learning beyond the classroom. Ebner et al. (2010) also found that online professional learning communities could connect those who were geographically separated.

Online professional learning communities can be supported by the elements of content, process, and context (Hoadley, 2012). Content refers to the capacities of technology, such as how
different forms of information are managed and stored within online professional learning communities. The process is the capability of the technology being used within online professional learning communities to facilitate activities, carry out tasks, or support different sequence of actions undertaken by participants. Context refers to capacity of the technology in online professional learning communities to effect and change the social context of participants.

Hoadley and Kilmer (2015) developed the C4P framework for online professional learning communities that depicts how knowledge is produced and shared when there is a purposeful conversation around content in context (see Figure 2). The framework has five components: content, conversation, connections, information context, and purpose. Content refers to already existing knowledge objects such as documents or video clips, which contribute information to online professional learning communities. Conversation refers to the online discussions that occur in online professional learning communities, which can be the most effective mode of knowledge transfer and generation. Connections are the relationships and trust between participants in online professional learning communities that enable them to work jointly on the shared goal of building their knowledge domain. Information context is what allows the participants in online professional learning communities to determine why and how information being shared is relevant to them and how to apply the knowledge to their own situations. Purpose is the reason for which members came together to form online professional learning communities, which is the defining factor in collaboration. Together, these five elements work together to create viable and successful online professional learning communities.
The need for communication and connection has led to the creation and usage of different types of online professional learning communities in the field of agricultural education. The rationale for the formation of online professional learning communities in agricultural education can be rooted in the issue of agriculture teacher retention. The United States is currently facing a shortage of agriculture teachers (Foster, Lawver, & Smith, 2016), and efforts are underway to increase retention of those teachers already in the classroom (Smalley & Smith, 2017). One major threat to the retention of secondary school-based agricultural educators is a sense of isolation from others within their field, and the lack of access to a traditional, in-person community of practice (Smalley & Smith, 2017). When this occurs, agricultural educators can turn to technology to create the valuable mentoring relationships that help to address the issue of isolation from others in the profession.
Collaborative web technologies can help cultivate online professional learning communities for professional development. Gunawardena et al. (2009) found that online professional learning communities can also facilitate the sharing of knowledge and encourage reflection to consider new knowledge gained and how that knowledge was influenced by the online social network. Risser (2013) found that teachers use online professional learning communities to communicate with other professionals, to get updates on the latest news in education, and to share resources with each other.

Wenger (2007) also studied online professional learning communities and found that the use of an online professional learning community can provide teachers with an opportunity to build relationships and learn from each other. Through the use of technology online professional learning communities can be more convenient, flexible, and offer just-in-time support for teachers when compared to traditional communities of practice (Wang & Lu, 2012). Additional evidence has shown that online professional learning communities have been developed in many different educational areas to connect peers that do not work near each other to increase informal learning in career fields (Dolan, 2013; Kim & Canvas, 2013). In addition, online professional learning communities have been shown to be beneficial with teachers at all different stages of their careers. Paulsen et al. (2015) explored the use of online professional learning communities with pre-service agriculture teachers and found it to be very helpful in connecting with other agricultural educators.

Hoadley (2012) defined four different ways that technology can be used to support online professional learning communities. Technology is an efficient want to connect teachers with others having similar practices. It can also be used to provide a shared repository of information resources created by and for teachers. Technology can be used as a tool for facilitating
discussions amongst teachers to support professional communication and resource sharing. Finally, the technology used in online professional learning communities can raise awareness of new knowledge, resources, and practices for teachers through the sharing of different artifacts and through professional conversations. 

Previous research has shown the benefits of social media platforms, which are popular host platforms for online professional learning communities, in engaging educators through sharing ideas, which can be used in classrooms and to improve their professional practices (Wesley, 2013). Gunawardena et al. (2009) found that online professional learning communities facilitated by online social networks, such as Twitter, can result in increased social interaction among users after participating in sharing of ideas, resources, and knowledge. They also noted that online professional learning communities could facilitate the sharing of knowledge and encourage reflection to consider new knowledge gained and how the online social network influenced that knowledge. 

Xue, Hu, Chi, and Zhang (2019) developed a framework for how online professional learning communities for professional teacher learning and discussion can be hosted using social media (see Figure 3). In their framework, content refers to the digital artifacts that are generated, presented, and shared by online professional learning communities’ participants to foster connections and conversations. The conversations are the interactions between participants about the context and that are carried out using different forms of digital communication within online professional learning communities. The connectivity component of the framework refers to how participants in online professional learning communities use digital communication to form connections based on trust and to spark dialogue. The context aspect of the framework refers to
the purpose or subject of online professional learning communities that links participants and that the context, conversations, and connections are centered around.

Figure 3

*Social Media-Based Online Professional Learning Communities (Xue et al., 2019)*

When creating online professional learning communities, a clear sense of shared purpose creates a culture of productive conversation, through which everyone engaged is aware that the goal of every conversation is to support the purpose of online professional learning communities. Xue et al. (2019) suggest that having a clearly defined shared purpose of online professional learning communities fosters a culture of productive conversation, through which everyone engaged are aware of the fact that the goal of conversations within online professional learning communities is to support their purpose. They also recommend creating relationships and discussions between participants that are carefully thought out and facilitated by shared purpose and quality content. In addition, they advocate for constantly reinforcing and reminding DCOP
participants of the context of online professional learning communities to help establish knowledge among people who are not physically located in the same spot. This helps online professional learning communities’ members make connections between one another, gain access to context about each other’s roles in and contributions to online professional learning communities, and find ways to apply the knowledge generated from online professional learning communities to their own lives (Xue et al., 2019). One way to help all of these things to occur in online professional learning communities is to establish a digital ecosystem.

*Digital Ecosystem*

A digital ecosystem is an interdependent group of people that share an established group of digital platforms for a mutually beneficial purpose, such as a common interest, and that is based off of the adaptive and sustainable processes from natural ecosystems (Briscoe, Sadedin, & De Wilde, 2011). Just like in a natural ecosystem, different individuals shape the social network based on what happens through their interactions with one another. Within a digital ecosystem, certain digital platforms are used to communicate and share ideas.

Platform selection for a digital ecosystem can be based on many different factors. Research conducted by Liu et al. (2015) and Paulsen et al. (2015) demonstrate that both pre-service teachers and veteran teachers develop professionally in relation to technology integration when they engage through different digital platforms. Common platforms used to establish digital ecosystems for digital communities of practice involve blogging and social media.
Matheson (2004) defines a blog as an electronic journal that users can continuously update, in their own words, online. There are a plethora of tools and websites that can be used to create blogs. Most utilize a simple interface to make it easy for any user to construct, without having to understand HTML or web scripting, and contain similar features to Microsoft Word (Yang, 2009). Many blogging tools allow users to add pictures, audio files, videos, and links to websites to improve the content and visual appearance of their blog posts.

The use of blogging has its merits in building on and improving upon the educational technology skills of teachers and has the potential to be a transformational technology for teaching and learning (Williams & Jacobs, 2004). It allows teachers to express and share information and ideas in a way that is digitally archived for later use, and that can be easily accessed by other educators. It also encourages them to engage in the writing and reflection process, which is often overlooked in the teaching and learning process. Farmer (2006) writes that blogging allows for the development of a digital community in order to empower the process of learning, while Montero-Fleta and Pérez-Sabater (2016) claim that writing blogs benefits teachers and learners in terms of enhancing their professional practices due to the factors of interactivity and realism existing in blogs. It allows them to converse on a variety of topics and subjects, and also allows for feedback in the form of comments left on blog posts.

Blogs can be useful in generating professional discourse in a digital community of practice in a variety of ways. They can be used for all members to generate a post in regard to a common theme or topic, and then leave feedback for one another to gain new insight or perspective on what is being discussed. Blogs can also serve as a way for members of a community of practice to share resources related to a common idea. In addition, they can also
serve as a space for reflection and asking questions that can be addressed in the form of comments by other members of the community.

Social media has been shown to help enhance the educational technology usage of teachers at all stages of their career and has been used as a forum for professional communication to help expand teaching and learning beyond the classroom (Ebner et al., 2010). It allows teachers to share and communicate information in short, meaningful posts, and lends itself to instantaneous feedback. Paulsen et al. (2015) researched the use of a social media-based community of practice with pre-service agriculture teachers, while Wenger (2007) studied how an electronic community of practice via social media can provide pre-service teachers with an opportunity to build relationships and learn from each other. Through this process, both groups of teachers were able to improve on their proficiency with social media usage and were able to use this tool to share information and resources with one another.

A social media platform that is commonly used to for digital community of practice is Twitter. A 2010 study by Ebner et al. found that Twitter had great potential as a digital community of practice because of its ability to connect those who were geographically separated. Previous research has shown the benefits of social media platforms in engaging educators through sharing ideas, which can be used in classrooms and to improve their professional practices (Veletsiano, 2011; Wesley, 2013). Risser (2013) found that teachers use Twitter to communicate with other professionals, to get updates on the latest news in education, and to share resources with each other.

Twitter can also be useful in generating professional discourse in a digital community of practice. While users are limited by the number of characters that they have in each Tweet that they put out, they can use this to their advantage by only including critical information. It
employs educators to become efficient creators and consumers of the information contained in
the Tweets they read and generate. As Colwell and Hutchinson (2018) found that the use of
hashtags can help bring these important Tweets to the top of other members of the digital
community of practice Twitter feeds. This can also bring Tweets to the attention of others who
might be interested in the same topic, or who may be able to respond with helpful
information. Twitter is also a great platform for educators to use to share resources with one
another. Users can embed videos, websites, and images within their Tweets to make for easily
visible responses.

Another novel feature of Twitter as a digital ecosystem platform for an online
professional learning community is its ability to host Twitter chats. These chats can be conducted
synchronously or asynchronously and allow users to respond to questions on a certain topic using
a predetermined hashtag. Not only does this encourage the sharing of ideas and resources, it also
allows for the creation of a digital archive of all Tweets that contain the hashtag. A 2018 study
by Colwell and Hutchinson found that using a specific hashtag helped to group all tweets in the
same location on Twitter, ensured that users could easily locate each other’s tweets, and allowed
tweets to display with other similar disciplinary posts that educators or disciplinary experts might view.

Online professional learning communities can also be created through the usage of video
observation. Video observations involve the recording of teaching episodes for later review and
feedback. These videos can be uploaded to password protected video platforms, such as Edthena,
so that other professionals can review them in a secure and confidential manner. These platforms
can serve as archives for past teaching episodes, and can also provide a space for feedback and
discussion. Teacher assessment, certification, and observation are relying more heavily on
technology and video recordings of teachers for evaluative purposes, and gaining practice with video observation can be beneficial for pre-service teachers (Reese, 2016).

Participating in video observations bring the traditional practice of in-person observation into the twenty first century and creates the opportunity for more people to participate in the observation and feedback process. Recording teaching episodes and uploading them to an electronic observation platform allows teachers to watch and reflect on their lesson after the fact (Murphrey, Rutherford, Doerfert, Edgar, & Edgar, 2014). This helps teachers develop skills in noticing and analyzing their own teaching, which in turn can help them improve their teaching and learning practices (van Es, Cashen, Barnhart, & Auger, 2017).

**PCK, TPACK, and TPACK-Deep**

Communities of practice have long served as spaces for educators to engage in discourse and resource sharing around pedagogical content knowledge (PCK). Shulman was the first to create a visual model of PCK where PK stands for pedagogical knowledge, CK stands for content knowledge, and PCK represents the intersection of the two (1987, 1986) (see Figure 4). As traditional communities of practice have evolved into online professional learning communities, how educators engage in PCK has changed as well.
A new framework was designed by Koehler to depict how technological, pedagogical, and content knowledge (TPACK) work together to allow educators to integrate the use of technology into PCK (Koehler & Misra, 2009). TPACK emphasizes the dynamic interaction and integration of knowledge with the use of technology and describes the use of technology to support specific pedagogies within a particular content area. It also describes the use of technology as an instructional technique and how the use of technology to help teachers improve student learning (Thompson & Mishra, 2007). TPACK can be used to understand how teachers’ understanding of educational technologies and PCK interact with one another to produce effective teaching with technology. The TPACK model illustrates the complex interactions between content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK) (see Figure 5).
Figure 5

Technological, Pedagogical, and Content Knowledge (TPACK) Model (Koehler & Mishra, 2009)

To reflect the increased role that technology plays in the teaching process, the TPACK model was further enhanced in a 2015 study conducted by Liu et al. They adapted the technological content knowledge (TCK) component to refer to knowledge of how to use technology in order to develop innovative ways of teaching content, and the technological pedagogical knowledge (TPK) components to describe how teaching and learning can change when technologies are used in specific ways. With these additions, the overall TPACK model can be applied as a framework for an online professional learning community that incorporates and shares the knowledge required by teachers to integrate technology in the classroom for specific content areas and to demonstrate best practices for effective teaching by using technology (Koehler & Mishra, 2009).
The TPACK framework has been further expanded into the TPACK-deep model, which was developed by Kabakci, Yurdakul, Kilicer, Coklar, Birinci, and Kurt (2012). As shown in Figure 6, the TPACK deep-scale has four components that comprise its structure: design, exertion, ethics, and proficiency. The design factor encompasses an educator’s ability to design and develop technology-supported teaching processes to improve learning. The exertion component of the model is made up of an educator’s ability to select and use appropriate technologies in various teaching tasks, such as planning and evaluation. The ethics portion refers to an educator’s demonstration of legal and ethical behavior regarding the use of technology in teaching and learning practices. The final component of the model, proficiency, is made up of an educator’s leadership skills in the process of integration of technological resources into teaching and learning practices (Kabacki et al, 2004). When reviewed as a whole model, the TPACK-deep framework can serve as a tool for examining different technology usage behaviors of teachers.

Figure 6

TPACK-Deep Model (Kabacki et al., 2004)
Digital literacy can be defined as the ability to find, organize, understand, evaluate, and analyze information using digital technologies and the ability to understand and use existing advanced technology (Ata & Yıldırım, 2019). A digitally literate teacher is one that has knowledge of the different technological tools that are beneficial for their own teaching and for their students' learning. A digitally literacy teacher knows how to use the tools and model their uses and are able to teach their students about the technologies and their uses (Ng, 2012).

Digital literacy is having the technical ability to use technology to improve teaching through the use of multiple platforms and tools for instruction and professional communication. It is also the awareness, attitude, and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyze, and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action (Koltay et al., 2015). Educator digital literacy can be defined by examining different behaviors related to technology usage in teaching and learning practices.

Digital literacy behaviors for teachers involve the technical and operational skills to use information communication technology for learning and in everyday activities, the ability to think critically in the search, evaluate and create cycle of handling digital information, and the capability to use the internet responsibly for communicating, socializing and learning (Ng, 2012). Digital literacy behaviors include the ability to use basic information and communication technology skills, as well as the application of more advanced skills regarding the creative and critical use of digital tools (Sefton-Green, Nixon, & Erstad, 2009). In their 2018 study, Güneş
and Bahçivan define the digitally literate teacher as one who is “expected to have numerous competencies, such as using technology to improve teaching, being familiar with technology tools, having a positive attitude towards the use of technology in teaching practice, and having adequate technical, cognitive and socio-emotional skills in digital literacy.”

Digital literacy has previously been studied in pre-service teachers in Australia by Ng (2012). The study aimed to measure the digital literacy levels of pre-service teachers who had been exposed to learning technology throughout their time in the classroom, and who were enrolled in an online learning course to expand their knowledge of teaching and learning with technology. As part of the study, Ng developed a model that depicted digital literacy in the pre-service teachers as a combination of three factor areas: cognitive, social-emotional, and technical, as outlined in Figure 7.

Can we teach digital natives digital literacy?

![Factors Influencing Digital Literacy (Ng, 2012)](image-url)

*Figure 7*
Ng defined cognitive digital literacy as the ability to think critically in the search, evaluate and create cycle of handling digital information and being able to evaluate and select appropriate software programs to learn with or to do a specific task. Socio-emotional digital literacy was defined as the ability to use the Internet responsibly for communicating, socializing and learning. Technical digital literacy was defined as possessing the technical and operational skills to use technology for learning and in everyday activities (Ng, 2012).

The results of Ng’s study showed that pre-service teachers perceived having improved their digital literacy through the explicit teaching and learning in the course about new educational technologies and their integration into their learning (2012). The research findings also showed that the course had the biggest (positive) impact on the students in the technical dimension of the digital literacy framework, especially in the areas of the students' skills to create content with digital tools and their ability to solve technical issues. As a result of these findings, Ng recommended that digital literacy development, which was defined as the equipping of students with a repertoire of tools and cognitive capabilities to help them live in a technologically oriented society that would inevitably require them to be able to adopt new technologies or adapt to changes to existing technologies, be incorporated into pre-service teacher coursework (2012).

Ata and Yıldırım (2019) recommend that digital literacy courses should be integrated into current teacher training as a stand-alone elective and that elements of digital literacy should be included in all teacher education programs and course work. To accomplish this, they suggest that practical activities should be included in the development of digital literacy of pre-service teachers along with theoretical courses on the subject. They also recommended that teacher
educators observe the extent to which pre-service teachers can use digital skills in practice and formal course settings.

*Digital Technology Self-Efficacy*

Digital technology self-efficacy is the self-assessment of one’s capabilities to use certain forms of digital communication technology. The roots of technology self-efficacy can be traced back to the work of Dr. Albert Bandura. He defined self-efficacy as the self-assessment of a person’s capabilities to attain a desired level of performance in a given endeavor (1986).

According to Bandura’s (1986) social cognitive theory, an individual’s self-efficacy belief influences their choice of activities, how much effort they will expend, and how long they will sustain effort in dealing with stressful situations. Wu and Wang (2015) found that the application of Bandura’s social cognitive theory to teachers’ technology self-efficacy is crucial and should be highlighted by teacher educators. It was recommended that when designing training programs for improving teachers’ technology self-efficacy, teacher educators should pay particular attention to how to increase their use of sophisticated online educational technology, and that teachers should be guided to practice making use of their reflective abilities in technology-related tasks.

Teachers’ self-efficacy has been identified as an important variable that is related to their use of technology (Pynoo, Devolder, Tondeur, van Braak, Duyck, & Duyck, 2011). Technology self-efficacy can be a key determinant of both initial technology usage and long-term usage intentions and behaviors (Sun, 2008). Teachers’ self-efficacy is consistently and strongly related to their usage of technology in their teaching and learning practices (Kao, Tsai, & Shih, 2014).
Teachers with higher technology-related self-efficacy have increased inclinations to use technology in their teaching and learning practices (Paraskeva, Bouta, & Papagianni, 2008).

Because teachers use technology in many different ways in their teaching and learning practices, specialized technology self-efficacy terms have been developed. Kao et al. (2014) divide technology self-efficacy into three main types: computer self-efficacy, Internet self-efficacy, and web-based professional development self-efficacy. Computer Self-Efficacy (CSE) can be considered a domain specific measure of self-efficacy that reflects a person’s belief in his/her ability to perform specific computer tasks. Internet Self-Efficacy (ISE) examines learners’ confidence in their general skills or knowledge of operating Internet functions or applications in the Internet-based learning condition. Web-based professional development self-efficacy (WPDSE) explores teachers’ confidence in their participation in and their expected performance of using web-based professional development.

Kao and Tsai (2009) proposed that teachers with high Internet self-efficacy may have a greater chance of success in web-based-related tasks related to teaching and learning practices. Teachers who possess higher Internet self-efficacy have been found to accept new learning ideas more easily and are usually more willing to try various teaching methods using web-based technology to provide students with different learning experiences (Chen & Tseng, 2012). As such, teachers’ self-efficacy in using web-based information technology would influence their willingness to utilize technology in their teaching and learning practices.

A 2018 study by Hatlevik and Hatlevik found that teachers prefer to develop digital competence and technology self-efficacy through collaboration with other teachers, and that this collaboration has a substantial association with teachers' technology self-efficacy for instructional purposes as well as their use of technology during instruction. Research has shown
a positive relationship between self-efficacy in using digital tools and the use of technology for teaching purposes (Teo, 2011). Technology self-efficacy levels tend to be higher for those teachers who are confident in their digital skills and use this raised sense of self-efficacy for influencing students’ use of technology in the classroom (Elstad & Christophersen, 2017). Teachers' technology self-efficacy is not a constant, but it is affected by factors such as mastery experiences, vicarious experiences, such as mentoring, and feedback from others who have a significant impact on their teaching practices (Hatlevik & Hatlevik, 2018).

Digital technology self-efficacy has been previously studied by Lemon and Garvis (2016), who examined the perceived levels of pre-service teachers’ self-efficacy in teaching with technology. They found that those pre-service teachers who had access to coursework in how to incorporate and use educational technology had higher perceived levels of technology self-efficacy than those pre-service teachers who had not had access to that type of coursework. The study recommended further exploration into what influences assist technology self-efficacy in pre-service teachers including university context, practicum contexts, personal to professional use, and combinations of those areas.

It has been found that learners’ computer attitudes are positively correlated with their computer self-efficacy (Pamuk & Peker, 2009). Also, learners with greater Internet self-efficacy may have more positive attitudes toward web-based professional development (Kao & Tsai, 2009). Expanding on the Theory of Planned Behavior (TPB), Ajzen (2002) proposed that behavioral intentions are influenced by attitudes and self-efficacy. It has been found that beliefs and attitudes are the key determinants of both initial technology usage and long-term usage intentions and behaviors (Sun, 2008). In light of the previous research, it can be concluded that a
learner’s self-efficacy and attitudes toward technology are consistently and strongly related to their usage of the technology.

*Attitude Toward Technology*

Attitude toward technology is the beliefs held and experiences had by individuals that contribute to their use of technology. It can also be defined as the factors that name, define, and describe the structure and content of the mental states that are thought to drive a person's actions and that are expected to predict one's uses of technology (Bai & Ertner, 2008). Teachers' beliefs and attitudes about technology shape the choices they make in the classroom regarding the use of technology in teaching and learning practices (Hobbs & Tuzel, 2017).

Teachers’ attitudes towards technology can be impacted by a variety of factors, such as those described by Reid (2017). Reid identified the technology itself, the process of using it, how it is administered, the environment in which it is implemented, and faculty dynamics as major players into whether a teacher will or will not choose to adopt technology in their classrooms. These factors, both by themselves and in combination, play a major role into an educator’s attitude towards technology. Reid also found that how educators experience the different items related to technology adoption, such as training, hardware/software support, and updates, can contribute to positive or negative perceptions of the new technology being introduced (2017). This was also noted by Ata and Yıldırım (2019) who found that one of the issues related to teacher attitudes towards the use of digital technologies was having the necessary active teaching strategies to incorporate it into their teaching and learning practices.
Teacher attitude towards educational technology plays a significant role as to whether they will choose to use it for personal and professional practice. There are a variety of factors that influence an educator’s attitude towards technology. The most common of these factors are individual and personal preferences, beliefs, and comfort levels in how pedagogy, content, and technology mix (Reid, 2017). Time in the profession is also an influencer for attitude toward technology, with those educators who are newer to the profession being more likely to utilize educational technology than those who have been in the classroom for a longer period of time (Mitchell, Wohleb, & Skinner, 2016).

It has been found that teachers’ attitudes towards technology are positively correlated with their technology self-efficacy (Pamuk & Peker, 2009). Those teachers with greater technology self-efficacy may have more positive attitudes toward using technology in their teaching and learning practices (Kao & Tsai, 2009). Sun (2008) found that beliefs and attitudes are the key determinants of both initial technology usage and long-term usage intentions and behaviors of teachers.

Attitudes towards technology can also be influenced by comfort level (Reid, 2017). Teachers who are not comfortable with or skilled in using educational technology are also less likely to utilize with their students and in their coursework. Others may fear that their students know more about technology than they do, and may choose not to use it in their classroom for fear that their students may take advantage and use the technology for things other than purely educational purposes (Forrer, Wyant, & Gordin, 2014).

Teachers can also influence their attitude toward technology in a variety of other ways. Those who are more familiar with educational technology uses and who have a positive attitude towards it, are more likely to use it in their coursework (Bai & Ertner, 2008). On the flip side,
those who have become accustomed to more traditional forms of classroom instruction, or who are not comfortable with educational technology, are less likely to utilize it in their teaching and learning practices.

Teacher attitudes toward technology were previously studied by Kao et al (2014) who examined how teachers’ attitudes towards technology impacted their likelihood to participate in digital professional development. They found that teachers’ ability to use digital tools is not the most significant factor to predict their attitudes toward web-based professional development. Their recommendations included finding effective ways to improve teachers’ perceptions of engaging in interaction in online learning activities and their capacity to use technology-related teaching methods in the classroom to enhance and improve their attitudes towards technology usage (Kao et al., 2014).
The conceptual model that guided the study is presented in Figure 8. The virtual mentoring program that was examined in the study was occurred when several key elements of the teaching and learning process: communities of practice, mentoring, and pedagogy content knowledge were combined with technology. Mentoring of teachers has long been something that has occurred in person. However, with the development of technology tools that allow for efficient digital communication, mentors and mentees no longer need to be in the same location for authentic mentoring experiences to occur (Reese, 2016). In agricultural education, it is not uncommon for teachers to be geographically separated from one another. Virtual mentoring
allows for valuable professional development opportunities for both new and experienced teachers whose geographic location makes having face-to-face mentoring relationships difficult (Reese, 2016).

Communities of practice have traditionally served as forums where teachers can discuss pedagogy content knowledge (PCK) and best practices for the teaching profession (Wenger et al., 2007). When technology is added to a community of practice, it can result in the creation of online professional learning communities (Liu, 2012). Like, traditional communities of practice online professional learning communities can serve as a place for the focusing on PCK. Because online professional learning communities require the use of technology, they allow for the creation of spaces where technological pedagogy and content knowledge (TPACK) can be discussed and best practices for teaching and learning with technology can be shared (Koehler & Mishra, 2009). The virtual mentoring program allowed mentors and mentees to participate in an online professional learning community on a regular basis.

Within online professional learning communities, digital ecosystems can arise. Digital ecosystems can include platforms related to digital communication, reflection, and observation. Through participation in professional learning communities, teachers can gain experience and proficiency with using tools such as Twitter, blogging, and video observation, which are commonly used in the classroom (Liu et al., 2015; Paulsen et al., 2015). As part of the virtual mentoring program, pre-service and in-service agriculture teachers participated in a digital ecosystem that utilized Twitter, Blogger, and Edthena, a video observation platform.

Participation in online professional learning communities also allows teachers to develop behaviors that can enhance their educational technology proficiency. Digital literacy, technology self-efficacy, and attitude toward technology have been identified as important traits for new and
experienced teachers to develop and exhibit (Nascimento & Knobel, 2017). Using the different platforms of a digital ecosystem in a place where there is support from others serves as a way for teachers to improve their technology self-efficacy (Hatlevik & Hatlevik, 2018). Sharing ideas for how technology can be used in the teaching and learning process helps to expand digital literacy (Koltay et al., 2015). Having positive experiences using technology for teaching and learning in a space where there the opportunity to develop active teaching strategies can lead to a positive attitude toward technology (Ata & Yıldırım, 2019). The virtual mentors chosen for the virtual mentoring program exhibited high levels of digital literacy and technology self-efficacy, along with a positive toward technology, and sought to help their mentees improve their own digital literacy, technology self-efficacy, and attitude by engaging in shared digital tasks and experiences.

The study aims to examine how participating in a virtual mentoring program impacted technology usage behaviors and digital communication platform usage of pre-service agriculture teacher mentees and in-service agriculture teacher mentors. The virtual mentoring program examined in the study utilized an online professional learning community with a pre-defined digital ecosystem embedded in it. Through using Twitter, blogging, and video observation as the primary digital communication tools, mentors and mentees were able to exchange feedback and ideas to enhance their capacity with TPACK. Such interactions also allowed mentors and mentees the opportunity to improve their digital literacy and technology self-efficacy skills, and to develop a positive attitude toward technology.
Summary

Chapter two explored literature related to four primary areas: Communities of Practice (CoP), Digital Ecosystems, Technological Pedagogical, and Content Knowledge (TPACK), and mentoring. Specifically, chapter two described how mentoring and traditional communities of practice can be transformed into virtual mentoring through the addition of technology, specifically in education through communities of practice. The increase of digital communication has led to the evolution of professional online learning communities and new methods for discussions about teaching and learning with technology. Professional online learning communities commonly operate in digital ecosystems and utilize specifically defined technology platforms for communication and information sharing such as blogging, social media, and video observation. The addition of technology to the teaching equation has led to the traditional pedagogy content knowledge (PCK) framework being transformed into the technology pedagogy and content knowledge (TPACK) framework. Specific teaching with technology behaviors have further been identified within the TPACK-Deep framework, which helped to guide this study. Chapter two concluded with the presentation and description of the conceptual model that guided the study.
CHAPTER 3

METHODS

Chapter three presents the quantitative research methods used to guide the study including study population selection methods and survey instrumentation. Survey administration protocols are explained. A discussion of how the survey instrument data was collected and analyzed is presented.

Research Perspective and Research Design

The study used a quantitative research perspective to examine how the participation in a virtual mentoring program impacted the digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication for pre-service agricultural teacher candidates and in-service agricultural educators. Quantitative research examines the relationship between study variables using a variety of statistical analysis procedures (Creswell, 2013). Quantitative research can involve examining the cause of a social phenomenon, such as virtual mentoring.

The epistemological perspective of quantitative research states there is only one reality, which is objective and exists outside the experiences of researchers and study participants (Creswell, 2013). The ultimate goal of a quantitative research perspective is to develop generalizations by examining the presence or absence of a relationship between study variables and making inferences about a phenomenon (Creswell, 2013). The knowledge generated from a quantitative study is based on data, evidence, and rational considerations, and the researcher
collects information from an instrument completed by participants. To remain objective in quantitative research, the researcher must examine methods and conclusions for potential bias, address potential sources of error, and establish standards of reliability and validity for the instrument being used (Cresswell, 2013).

Descriptive quantitative research was used to explore and describe the impact of virtual mentoring program participation on digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication for pre-service agricultural teacher candidates and in-service agricultural educators. The study described how participation in virtual mentoring program impacted the technology behaviors of two groups of agricultural educators: pre-service teachers and in-service teachers. Each group was divided into the sub-groups of those who have participated in a virtual mentoring program, and those who have not participated in a virtual mentoring program.

Obtaining valid data can be difficult for descriptive studies, as data collection often involves participants self-reporting. Self-reporting of data can contribute to one of the largest threats to a descriptive study: internal validity, which measures if the data being collected is valid and true (Gay, Mills, & Airasian, 2006). Internal validity can be impacted by poorly-stated questions, ambiguous questions, lack of clear instructions, an inability to recall information, and participants deliberately lying in their responses.

To address internal validity for the study two interventions were used: (1) construct validity and content validity were addressed by a panel of experts, and (2) face validity assessment through cognitive interviews with members of the representative population who were not subjects in the study. The instrument was reviewed for face validity by a pre-service agriculture teacher and an in-service agriculture teacher to collect feedback on any poorly-stated
or ambiguous questions and clarity of instructions. The information was used to clarify the wording of questions and instructions that were identified as difficult to understand or unclear. External validity, whom the research can be generalized to, is also a threat to descriptive research. Lack of participant response is a major contributor to external validity, as it can result in low response rates and difficulty interpreting the data that represents the views of non-respondents (Gay et al., 2006). Sampling error, frame error, selection error, and non-response error can also be threats to external validity if they are not addressed properly in the design of the study methods.

Reliability tests of the survey instrument were conducted through pilot testing for both pre-service and in-service agriculture teachers prior to the instrument being administered to study participants. The information from the pilot tests was used to remove any questions that posed a threat to the overall reliability of the instrument.

**Purpose and Objectives**

The purpose of the study was to describe the impact of virtual mentoring program participation on digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication for pre-service agricultural teacher candidates and in-service agricultural educators. The following research objectives guide the study:

1. Describe the digital literacy of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.
2. Describe the digital literacy of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.

3. Describe the digital technology self-efficacy of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument.

4. Describe the digital technology self-efficacy of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument.

5. Describe the attitudes towards digital communication of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using Aydin and Kaa’a’s (2013) Attitudes Toward Technology instrument.

6. Describe the attitudes towards digital communication of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using Aydin and Kaa’a’s (2013) Attitudes Toward Technology instrument.

7. Compare Twitter usage, blogging usage, and video observation usage of pre-service agriculture teacher and in-service agriculture teacher populations who have and have not participated in a virtual mentoring program.
**Explanation of Study Framework and Methodology**

The study examined how participation in a virtual mentoring program affects the TPACK behaviors of digital literacy, technology self-efficacy, and attitude towards technology of in-service and pre-service agricultural educators (see Figure 9). The independent variable for the study was participation in a virtual mentoring program. The variable was categorical, and participants were only permitted to select only “yes” or "no" as their response choices.

The dependent variable for the study was influence on the TPACK behaviors of digital literacy, technology self-efficacy, and attitude toward technology. The dependent variable was numerical and measured by the scored response to the survey instruments. Participants read different statements about technology usage as it is related to digital literacy, technology self-

---

**Figure 9**

*Study Methods Model (Morey, 2020)*

The study examined how participation in a virtual mentoring program affects the TPACK behaviors of digital literacy, technology self-efficacy, and attitude towards technology of in-service and pre-service agricultural educators (see Figure 9). The independent variable for the study was participation in a virtual mentoring program. The variable was categorical, and participants were only permitted to select only “yes” or "no" as their response choices.

The dependent variable for the study was influence on the TPACK behaviors of digital literacy, technology self-efficacy, and attitude toward technology. The dependent variable was numerical and measured by the scored response to the survey instruments. Participants read different statements about technology usage as it is related to digital literacy, technology self-
efficacy, and attitude toward technology and selected from five Likert-scale responses. Responses were coded to create an overall score for each technology behavior.

In the model, two distinct groups of pre-service and in-service agriculture teacher participants are depicted: those who have participated in a virtual mentoring program, and those who have not participated in a virtual mentoring program. Participation in a virtual mentoring program involved regular usage of the three digital communication platforms: Twitter, blogging, and video observation. Platform (Twitter, blogging, video observation) usage influence on the TPACK behaviors of interest is unknown. The study examined if significant differences exist between those agriculture teachers who have and have not participated in a virtual mentoring program, and if there is a relationship between the utilization of three forms of digital communication (Twitter, blogging, and video observation) and virtual mentoring program participation.

**Study Population Selection**

Participants in the study were pre-service agriculture teachers and in-service agriculture teachers who had or had not participated in a virtual mentoring program of the Agricultural Teacher Education Program at The Pennsylvania State University and were not compensated for their participation in the study. For pre-service agriculture teachers, a census method was used. All pre-service agriculture teachers from The Pennsylvania State University who had participated in the virtual mentoring program were surveyed for the program participant group. All current pre-service agriculture teachers at The Pennsylvania State University who had not participated in the virtual mentoring program were surveyed for the non-participant group.
The in-service agriculture teacher virtual mentoring program participation group comprised four types of individuals: recent program graduates from The Pennsylvania State University, in-service agriculture teachers from the state of Pennsylvania who were not serving as cooperating teachers, cooperating teachers from the state of Pennsylvania, and out-of-state agriculture teachers. These participants had all volunteered to serve as virtual mentors and were not compensated for this role or their participation in the study. A census was taken and all individuals from this group were surveyed (see Table 1).

The in-service agriculture teacher non-participant group comprised Pennsylvania agriculture teachers who had no prior affiliation or experience with the virtual mentoring program. Because the population of agriculture teachers who met these requirements was greater than the number of agriculture teachers who had participated in the program, a random number generator was used to select study participants to ensure that the two comparative groups were of equal size (see Table 1). Ensuring that groups were of equal size helped to prevent a loss of statistical power and to decrease the likelihood of Type I error (Urdan, 2010). None of the teachers selected were compensated for their time or study participation.
Survey Instrument Development

The survey instrument was designed to capture information on digital literacy, technology self-efficacy, and attitudes towards technology. The instrument included a combination of questions taken from three existing instruments. Each instrument independently measured digital literacy, technology self-efficacy, or attitudes towards technology, and had previously been used with pre-service teachers in the past.

The questions related to digital literacy were taken from the Digital Literacy Skills scale developed by Ng (2012). Ng's instrument consisted of 10 items evaluated from a 5-point Likert-type scale, with response choices of: *strongly disagree, disagree, neither agree or disagree, agree, and strongly agree*. The original instrument questions were not adapted. Table 2 presents examples of instrument items.
Table 2

Examples of Statements from Digital Literacy Instrument

<table>
<thead>
<tr>
<th>Digital Literacy Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I know how to solve my own technical problems.</td>
</tr>
<tr>
<td>2. I can learn new technologies easily.</td>
</tr>
<tr>
<td>3. I keep up with important new technologies.</td>
</tr>
<tr>
<td>4. I know about a lot of different technologies.</td>
</tr>
<tr>
<td>5. I have the technical skills I need to use technology for learning and to create digital artifacts (e.g. presentations, digital stories, wikis, blogs) that demonstrate my understanding of what I have learned.</td>
</tr>
</tbody>
</table>

Note. Responses to each statement are measured on a 5-point Likert Scale of Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, and Strongly Agree

The technology self-efficacy questions were taken from the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) developed by Kabakci-Yurdakul et al. (2012). This instrument measured TPACK competencies, which are reflective of technology self-efficacy. Kabakci-Yurdakul's instrument consisted of 33 items in a 5-point Likert-type scale, with response choices of: strongly disagree, disagree, neither agree or disagree, agree, and strongly agree. The original instrument questions were not adapted. Table 3 presents examples of instrument items.
Examples of Statements from Technology Self-Efficacy Instrument

<table>
<thead>
<tr>
<th>Technology Self-Efficacy Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I can update an instructional material (paper based, electronic or multimedia materials, etc.) based on the needs (students, environment, duration, etc.) by using technology.</td>
</tr>
<tr>
<td>2. I can use technology to determine students’ needs related to a content area in the pre-teaching process.</td>
</tr>
<tr>
<td>3. I can use technology to develop activities based on student needs to enrich the teaching and learning process.</td>
</tr>
<tr>
<td>4. I can plan the teaching and learning process according to available technological resources.</td>
</tr>
<tr>
<td>5. I can conduct a needs analysis for technologies to be used in the teaching and learning process to increase the quality of teaching.</td>
</tr>
</tbody>
</table>

*Note.* Responses to each statement are measured on a 5-point Likert Scale of Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, and Strongly Agree.

The questions related to attitudes towards technology were taken from an instrument that measures pre-service teachers’ attitudes toward technology that was developed by Aydın and Karaa (2013). Aydin and Karaa's instrument contained 17 items in a 5-point Likert-type scale, with response choices of: strongly disagree, disagree, neither agree or disagree, agree, and strongly agree. The original instrument questions were not adapted. Table 4 presents examples of instrument items.
Table 4

Examples of Statements from Attitude Toward Technology Instrument

<table>
<thead>
<tr>
<th>Attitude Toward Technology Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I believe that technology improves the efficiency of work.</td>
</tr>
<tr>
<td>2. I like to use technology.</td>
</tr>
<tr>
<td>3. I closely follow the work on technology.</td>
</tr>
<tr>
<td>4. I'm interested in technology research.</td>
</tr>
<tr>
<td>5. I believe in the necessity of technology for a better quality of life.</td>
</tr>
</tbody>
</table>

Note. Responses to each statement are measured on a 5-point Likert Scale of Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, and Strongly Agree.

Instrument Error, Reliability, and Validity

Instrument error, reliability, and validity of the survey instrument are addressed below. The section begins with a discussion of the four common types of error and plans to mitigate the error. The plans to address the threats to reliability and validity are addressed.

Coverage Error

Coverage error occurs when the list from which sample members are drawn does not accurately represent the population in terms of the characteristics or the difference between the estimate produced when the list is inaccurate and what would have been produced with an
accurate list. For a survey instrument to be considered high-quality, every member of the population from which the sample is being drawn has a known, nonzero probability of being sampled. This means that they have to be accurately represented on the list from which the sample will be drawn (Dillman, 2014). To reduce coverage error in the study, accurate sample frames for the two study populations of interest (pre-service agriculture teachers and in-service agriculture teachers) were used. The sample frame of pre-service agriculture teachers included all of the pre-service agriculture teachers enrolled at The Pennsylvania State University, which comprised a group of students at all different stages of the major and who have and have not had experience with the virtual mentoring program. The sampling frame for in-service agriculture teachers comprised all agriculture teacher virtual mentors and randomly selected agriculture teachers in the state of Pennsylvania, including teachers at all different stages of their career and who had or had not experienced the virtual mentoring program.

*Sampling Error*

Sampling error is the difference between the estimate produced when only a sample of individuals in the frame are surveyed and the estimate produced when all individuals in the sample frame are surveyed. Sampling error occurs when the researcher surveys only some members of the sample frame as opposed to all of them (Dillman, 2014). To minimize sampling error, two different methods can be used: conducting a census of the study population, and when this is not possible, increasing the sample size. Because the pre-service agriculture teacher population was small and contact information was readily available for all individuals, the census method was feasible for this group of study participants. As such, all members of this
group were sent the survey, and follow-up communication was conducted as needed to ensure that as many individuals as possible responded to result in a complete census. Sampling error was addressed for the portion of the in-service agriculture teacher population who had participated in the virtual mentoring program by conducting a census. This portion of the in-service teacher population was small and contact information was readily available for all individuals. In addition, they had an already established rapport with me making the in-service agriculture teacher virtual mentoring program participants more likely to respond to the survey.

Sampling error was addressed in the in-service agriculture teacher population who had not participated in the virtual mentoring program by sampling more individuals than are needed for a confidence interval of 95%, indicating a possibility of a 5% margin of error. The sample was determined by conducting a simple random sample using a random number generator.

Non-Response Error

Non-response error is the difference between the estimate produced when only some of the sampled individuals respond compared to when all of them respond (Dillman, 2014). To minimize non-response error, it is helpful to sample a larger number of participants to increase the response rate. Non-response error was addressed in the study by using multiple contact attempts for the survey instrument. Multiple contacts along with personalized communication and repeated opportunities to complete the survey were aimed to reduce the amount of non-response error. Once data was collected and analyzed, it was examined for non-response error.
Independent sample $t$-tests were used to examine if there was a difference between response time (early or late) and overall digital literacy, overall technology self-efficacy, and overall attitude toward technology for both pre-service and in-service agriculture teachers (see Table 5). The assumptions of Levene's test were met and equal variances were assumed for overall digital literacy score, overall technology self-efficacy score, and overall attitude technology score of pre-service agriculture teachers. The results of the $t$-tests showed no statistical significance for overall digital literacy score ($t(50) = 1.103, p = .278$), overall technology self-efficacy score, ($t(50) = -.066, p = .948$) and overall attitude toward technology score and the response time of pre-service agriculture teachers ($t(49) = .646, p = .951$). The assumptions of Levene's test were met and equal variances were assumed for overall digital literacy score, overall technology self-efficacy score, and overall attitude technology score of in-service agriculture teachers. The results of the $t$-tests showed no statistical significance for overall digital literacy score ($t(88) = -.813, p = .418$), overall technology self-efficacy score, ($t(88) = .933, p = .354$) and overall attitude toward technology score and the response time of in-service agriculture teachers ($t(86) = .337, p = .737$).
Table 5

*Independent Sample t-Test Results for Response Time and Overall Technology Behavior Score*

<table>
<thead>
<tr>
<th>Population</th>
<th>p-Value for Overall Digital Literacy Score</th>
<th>p-Value for Overall Technology Self-Efficacy Score</th>
<th>p-Value for Overall Attitude Toward Technology Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Service Agriculture Teachers</td>
<td>.275</td>
<td>.948</td>
<td>.521</td>
</tr>
<tr>
<td>In-Service Agriculture Teachers</td>
<td>.418</td>
<td>.354</td>
<td>.737</td>
</tr>
</tbody>
</table>

*Measurement Error*

Measurement error is the difference between the estimate produced by a survey instrument and the true value of the instrument because respondents gave inaccurate answers to survey questions (Dillman, 2014). Measurement error was addressed in the study by having the study instrument reviewed prior to administration by a pre-service agriculture teacher who was not involved in virtual mentoring program or the study. The instrument was also reviewed by an in-service agriculture teacher who was not involved in virtual mentoring program or the study. These individuals represented the survey populations of interest of pre-service agriculture teachers and in-service agriculture teachers.
The reliability for the instrument for the pre-service teacher population for the study was established from previous studies utilizing the instrumentation (Ng, 2012; Kabakci-Yurdakul et al., 2012; Aydin & Karaa, 2013). The reliability statistics and description of populations are shown in Table 6.

Table 6

Reliability of Survey Instrument Components: Pre-Service Teachers

<table>
<thead>
<tr>
<th>Survey Instrument Component</th>
<th>Pre-Service Teacher Candidate Population</th>
<th>Cronbach Alpha Reliability Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Literacy Skills Scale (Ng, 2012)</td>
<td>979 pre-service elementary, English, math, science, and social studies teachers</td>
<td>0.86</td>
</tr>
<tr>
<td>TPACK Deep Scale (Technology Self-Efficacy) (Yurdakul et al., 2012)</td>
<td>995 pre-service elementary, English, math, science, and social studies teachers</td>
<td>0.95</td>
</tr>
<tr>
<td>Attitude Toward Technology (Aydin &amp; Karaa, 2013)</td>
<td>1235 pre-service elementary, math, science, and social studies teachers</td>
<td>0.949</td>
</tr>
</tbody>
</table>

Note. α >0.90 = excellent, 0.90> α >0.80 = good, 0.80> α >0.70 = acceptable, 0.70> α >0.60 = questionable, 0.60> α >0.50 = poor, 0.50> α = unacceptable (Cronbach, 1951)

Reliability of the survey instrument for the in-service agriculture teacher population was verified through the utilization of a pilot test that was completed by 38 current secondary in-service agriculture teachers who were not part of the study population and were from a state other than Pennsylvania. Reliability tests were conducted using a Cronbach’s Alpha test for internal consistency (see Table 7). This test was run using the Statistical Package for the Social
Sciences (SPSS) software program and determined which items to delete to improve reliability. None of the survey questions were eliminated as a result of this test, which preserved content validity.

Table 7

**Reliability of Survey Instrument Components: In-Service Teachers**

<table>
<thead>
<tr>
<th>Survey Instrument Component</th>
<th>In-Service Teacher Candidate Population</th>
<th>Cronbach Alpha Reliability Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Literacy Skills Scale (Ng, 2012)</td>
<td>38 In-service agriculture teachers</td>
<td>0.818</td>
</tr>
<tr>
<td>TPACK Deep Scale (Technology Self-Efficacy) (Yurdakul et al., 2012)</td>
<td>38 In-service agriculture teachers</td>
<td>0.957</td>
</tr>
<tr>
<td>Attitude Toward Technology (Aydin &amp; Karaa, 2013)</td>
<td>38 In-service agriculture teachers</td>
<td>0.816</td>
</tr>
</tbody>
</table>

*Note. α > 0.90 = excellent, 0.90 > α > 0.80 = good, 0.80 > α > 0.70 = acceptable, 0.70 > α > 0.60 = questionable, 0.60 > α > 0.50 = poor, 0.50 > α = unacceptable (Cronbach, 1951)*

**Validity**

Validity is the extent to which an instrument is actually measuring what it is intended to measure (Leavy, 2017). Gates, Johnson, and Shoulders (2018) define validity as “a characteristic of the instrument, the subjects, and the decisions and inferences to be made using the data collected” (p. 2). There are three major types of validity that should be addressed in a research study: face validity, construct validity, and content validity. Face validity refers to the format and appearance of the instrument. Face validity can be established by using a panel of experts to
review the survey instrument (Leavy, 2017). Face validity was established by having a pre-service agriculture teacher enrolled in a similar pre-service agriculture teacher preparation program at a different university, who had not participated in a virtual mentoring program review the study instrument and an in-service agriculture teacher that had not participated in the virtual mentoring program review the study instrument. Cognitive interviews were conducted through separate Zoom meetings with the in-service agriculture teacher and the pre-service agriculture teacher, during which they completed the survey instrument. While completing the survey instrument, the two subjects provided feedback about the format and appearance of the instrument.

Construct validity refers to the measure that is examining the concept and related concepts of the survey instrument. Achieving construct validity requires creation of highly specific operational definitions. Construct validity can be addressed by ensuring that the variables being measured are clearly defined (Leavy, 2017). For the study, construct validity of the instrument was established with specific operational definitions. The operational definitions were included in the survey instrument to clarify the purpose and directions for each section of the instrument.

Content validity refers to the content and format of the instrument. It examines the appropriateness and comprehensiveness of the content and the adequacy of questions representing the content to be studied (Leavy, 2017). Content validity can be addressed by using a panel of experts to evaluate the study instrument. The panel of experts for this study consisted of an in-service agriculture teacher that had not participated in the virtual mentoring program and a pre-service agriculture teacher enrolled in a similar pre-service agriculture teacher preparation program at a different university who had not participated in a virtual mentoring program.
Cognitive interviews were conducted through separate Zoom meetings with the in-service agriculture teacher and the pre-service agriculture teacher during which time the subjects completed the survey instrument.

**Survey Instrument Administration**

The survey instrument was administered to participants through Qualtrics. Qualtrics was chosen because it will allow the survey instruments to be completed from any device with Internet connectivity, such as computers, tablets, and cell phones. Because Qualtrics is an internet-based application, lack of an Internet connection could be a potential barrier to survey completion for some participants who live in areas with poor internet connectivity.

The survey was sent to potential respondents via e-mail. Pre-service agriculture teachers were contacted using the email address assigned to them by The Pennsylvania State University. In-service agriculture teachers who participated in the virtual mentoring program were contacted using email addresses they provided for virtual mentoring program communication. In-service agriculture teachers who had not participated in the virtual mentoring program were contacted using school district email addresses listed in the Pennsylvania Agriculture Teacher Directory database. The survey administration procedure was developed using *Dillman’s Internet, Phone, Mail, and Mixed-Mode Surveys, The Tailored Design Method (4th ed., 2014)*. Separate survey administration protocols were followed for in-service agriculture teachers and pre-service agriculture teachers.

Due to the COVID-19 outbreak that occurred just prior to the beginning of data collection, the survey administration protocol for in-service agriculture teachers was revised. The
outbreak led to the closure of all public schools for the remainder of the school year, thus contacting in-service teachers via mail was no longer a viable option, as they would be unable to receive mail correspondence at their school mailing addresses. The COVID-19 outbreak also led to the decision to eliminate incentivizing participants for their participation in the study. Because of the closure of schools and universities, participants were not able to enter school or university buildings to access mail sent to them at school addresses or to pick up incentive items left for them in those locations. In-service teachers would have received a tea bag in the mail with the survey information letter. Pre-service teachers would have received a lollipop that they picked up in a building on The Pennsylvania State University campus. Providing an incentive has been shown to increase the likelihood that potential respondents will complete a survey instrument (Dillman, 2014). The incentives would have been able to be consumed by participants as they completed the survey instrument.

In-Service Agriculture Teacher Participants-Original Plan

The original survey administration timeline for in-service agriculture teacher participants is shown in Table 8. One week prior to the electronic survey being emailed to participants, a mailing was to be sent to all participants that contained a letter explaining the forthcoming survey instrument, the study objectives, and the importance of completing the instrument. Contact information for the participants was gathered from the databases of The Pennsylvania State University and The Pennsylvania Agricultural Education Directory. The mailing was to be sent in an envelope that contained the Penn State logo and included a tea bag as an incentive for completion of the survey instrument.
On the day of survey administration, all participants were to be emailed a link to the web survey. The link was to be sent from my Pennsylvania State University email account and included a short message explaining the purpose and importance of the survey. The survey link provided in the email was secure and unique for each survey participant.

Two weeks after the initial survey administration, an email reminder was to be sent to all non-respondents. This email was to be sent from my Pennsylvania State University email account. This allowed for a personalized email to be sent to each non-respondent. The reminder contained a personalized message from the researcher that explained the purpose and importance of completing the survey and a link to the survey instrument.

One week after the initial reminder email was sent, a paper survey was to be sent through the US mail to all remaining non-respondents. Along with a copy of the survey, a personalized letter from the researcher reminding the reader of the purpose and importance of the survey was to be included. The paper survey was to be identical to the web version and was to be printed on pastel-colored paper. Each participant was to be assigned a paper survey identified by a numerical code that was known only to myself. The codes were to be used to match each completed survey to a specific participant. A pre-paid addressed return envelope was to be included in the mailing to increase the likelihood of the paper surveys being completed and returned.


Table 8

*Original In-Service Agriculture Teacher Survey Instrument Administration Timeline*

<table>
<thead>
<tr>
<th>Time Point</th>
<th>Action</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Week Pre- Electronic Survey Administration</td>
<td>Letter</td>
<td>Study informational letter, paper copy of survey instrument, tea bag</td>
</tr>
<tr>
<td>Electronic Survey Administration</td>
<td>Email</td>
<td>Link to electronic survey instrument</td>
</tr>
<tr>
<td>2 Weeks Post- Electronic Survey Administration</td>
<td>Email</td>
<td>Survey reminder</td>
</tr>
<tr>
<td>1 Week Post-Reminder</td>
<td>Paper Mailing</td>
<td>Paper survey</td>
</tr>
</tbody>
</table>

*In-Service Agriculture Teacher Participants: Revised Plan*

The revised survey administration timeline for in-service agriculture teacher participants is show in Table 9. Two days prior to the electronic survey being emailed to participants, an email was sent to all in-service agriculture teacher participants that contained a letter explaining the forthcoming survey instrument and importance of completing the instrument, and a copy of the survey instruments for them to review as an attachment. Contact information was obtained from the virtual mentor database and The Pennsylvania Agriculture Teacher Directory database.

On the day of survey administration, all participants were emailed a link to the web survey. The link was sent from my Pennsylvania State University email account and included a short message explaining the purpose and importance of the survey. The survey link provided in the email was secure and unique for each survey participant.
Two weeks after the initial survey administration, an email reminder was sent to all non-respondents. This email was sent from my Pennsylvania State University email account. This allowed for a personalized email to be sent to each non-respondent. The reminder contained a personalized message from myself that explained the purpose and importance of completing the survey and a link to the survey instrument.

Two weeks after the initial reminder email was sent, a final reminder email was sent to all remaining non-respondents. This email was sent from my Pennsylvania State University email account. This allowed for a personalized email to be sent to each non-respondent. The reminder contained a personalized message from myself that explained the purpose and importance of completing the survey and a link to the survey instrument.

**Table 9**

*Revised In-Service Agriculture Teacher Survey Instrument Administration Timeline*

<table>
<thead>
<tr>
<th>Time Point</th>
<th>Action</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Days Pre- Electronic Survey Administration</td>
<td>Email</td>
<td>Study informational letter, copy of survey instrument</td>
</tr>
<tr>
<td>Electronic Survey Administration</td>
<td>Email</td>
<td>Link to electronic survey instrument</td>
</tr>
<tr>
<td>2 Weeks Post- Electronic Survey Administration</td>
<td>Email</td>
<td>Survey reminder</td>
</tr>
<tr>
<td>1 Month Post- Electronic Survey Administration</td>
<td>Email</td>
<td>Survey Reminder</td>
</tr>
</tbody>
</table>
The survey administration timeline for pre-service agriculture teacher participants is shown in Table 10. Two days prior to the electronic survey being emailed to participants, an email was sent to all pre-service agriculture teacher participants that contained a letter explaining the forthcoming survey instrument and importance of completing the instrument, and a copy of the survey instruments for them to review as an attachment. Contact information for the participants was gathered from the database of The Pennsylvania State University.

On the day of survey administration, all participants were emailed a link to the web survey. The link was sent from my Pennsylvania State University email account and included a short message explaining the purpose and importance of the survey. The survey link provided in the email was secure and unique for each survey participant.

Two weeks after the initial survey administration, an email reminder was sent to all non-respondents. This email was sent from my Pennsylvania State University email account. This allowed for a personalized email to be sent to each non-respondent. The reminder contained a personalized message from myself that explained the purpose and importance of completing the survey and a link to the survey instrument.

Two weeks after the initial reminder email was sent, a final reminder email was sent to all remaining non-respondents. This email was sent from my Pennsylvania State University email account. This allowed for a personalized email to be sent to each non-respondent. The reminder contained a personalized message from myself that explained the purpose and importance of completing the survey and a link to the survey instrument.
Table 10

*Pre-Service Agriculture Teacher Survey Instrument Administration Timeline*

<table>
<thead>
<tr>
<th>Time Point</th>
<th>Action</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Days Pre-Electronic Survey</td>
<td>Email</td>
<td>Study informational letter, copy of survey instrument</td>
</tr>
<tr>
<td>Administration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic Survey Administration</td>
<td>Email</td>
<td>Link to electronic survey instrument</td>
</tr>
<tr>
<td>2 Weeks Post-Electronic Survey</td>
<td>Email</td>
<td>Survey reminder</td>
</tr>
<tr>
<td>Administration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Month Post-Electronic Survey</td>
<td>Email</td>
<td>Survey reminder</td>
</tr>
<tr>
<td>Administration</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Data Analysis**

All data from survey responses was collected by and stored in Qualtrics. The data was exported to and saved as an Excel spreadsheet as a backup method. All information and data collected from survey respondents was stored on a secure server on a password protected Excel spreadsheet and Qualtrics account accessible from a password protected computer. The computer was in a locked office in the Ferguson Building on The Pennsylvania State University, University Park Campus. The data was only reviewed by the primary investigator for the study and all personal identifiers were removed from the data set prior to analysis. The data were analyzed in SPSS for normality and statistical testing. For the purpose of this study, a completed response is considered one that has 85% of the survey items answered. Only the completed survey responses were used for data analysis. Prior to statistical testing, the data were coded for
easier analysis and understanding of findings and results. The coding system is explained in Table 11.

**Table 11**

*Data Analysis Coding System*

<table>
<thead>
<tr>
<th>Data Collection Field Name</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant Type</td>
<td>1 (Pre-Service Agriculture Teacher), 2 (In-Service Agriculture Teacher)</td>
</tr>
<tr>
<td>Virtual Mentoring Participation Type</td>
<td>0 (Non-Participant), 1 (Participant)</td>
</tr>
<tr>
<td>Virtual Mentoring Program Role</td>
<td>1 (Mentee), 2 (Recent Program Graduate Mentor), 3 (In-State Agriculture Teacher Mentor), 4 (Out-of-State Agriculture Teacher Mentor), 5 (Cooperating Teacher), 6 (Recent Program Graduate Mentor and In-State Agriculture Teacher Mentor), 7 (Recent Program Graduate Mentor and Cooperating Teacher), 8 (In-State Agriculture Teacher Mentor and Cooperating Teacher), 9 (Out-of-State Agriculture Teacher Mentor and Cooperating Teacher)</td>
</tr>
<tr>
<td>Likert Scale Response</td>
<td>1 (Strongly Disagree), 2 (Disagree), 3 (Neither Agree or Disagree), 4 (Agree), 5 (Strongly Agree)</td>
</tr>
<tr>
<td>Twitter User</td>
<td>0 (Non-User), 1 (User)</td>
</tr>
<tr>
<td>Online Blogging Participant</td>
<td>0 (Non-Participant), 1 (Participant)</td>
</tr>
<tr>
<td>Type of Online Blogging Participation</td>
<td>1 (Author Blog Post), 2 (Leave Feedback/Comments on Blog Posts), 3 (Author Blog Posts and Leave Feedback/Comments on Blog Posts)</td>
</tr>
<tr>
<td>Video Observation Participant</td>
<td>0 (Non-Participant), 1 (Participant)</td>
</tr>
<tr>
<td>Type of Video Observation Participation</td>
<td>1 (Record and Upload Videos), 2 (Leave Feedback on Videos), 3 (Record and Upload Videos and Leave Feedback on Videos)</td>
</tr>
</tbody>
</table>
The data were analyzed using SPSS. Independent sample t-tests were used to compare those who had participated in the virtual mentoring program with those who had not for each item of the survey instrument and for overall digital literacy, technology self-efficacy, and attitude toward technology scores. Table 12 outlines each specific research objective, the survey question(s) that correspond to that objective, and the statistical measure that was being used to measure the objective.

Independent sample t-tests were used to compare the overall digital literacy values, technology self-efficacy values, and attitude towards technology values between those who have and have not participated in the virtual mentoring program for both the pre-service agriculture teacher and in-service agriculture teacher populations. Chi-square tests were used to see if there was a relationship between digital communication platform usage and virtual mentoring program participation for both pre-service agriculture teachers and in-service agriculture teachers.

Although the samples being compared were non-random, independent sample t-tests were used because the populations being compared were independent of one another. Random samples are one of the assumptions for independent sample t-tests. However, at times a random sample is an inaccurate representation of the sample it represents (Dorofeev & Grant, 2006). Because the populations of pre-service and in-service agriculture teachers who had participated in the virtual mentoring program were small and this study was exploratory, the decision was made that random sampling would not be feasible for these individuals to ensure that there were enough respondents (n>30) to allow for accurate data analysis (Urdan, 2010).

Due to the fact that the samples were not randomly selected, non-parametric Mann-Whitney U tests were also run for each independent sample t-test to check for consistency and accuracy of results. Three assumptions for the Mann-Whitney U test (dependent variable
measured on a continuous scale, independent variable with at least 2 categorical independent groups, independence of observations) were met (Urdan, 2010). However, one of the assumptions for the Mann-Whitney U test is that the data is not normally distributed (Urdan, 2010). The data for the study were normally distributed, so this assumption was violated. Because three of the four assumptions were met, the Mann-Whitney U was used as a secondary test to the independent sample t-tests.
<table>
<thead>
<tr>
<th>Research Objective</th>
<th>Corresponding Survey Questions</th>
<th>Statistical Test Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe the digital literacy of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.</td>
<td>10 Digital Literacy Questions (See Appendix C)</td>
<td>Independent Sample t-Test, Mann-Whitney U Test</td>
</tr>
<tr>
<td>2. Describe the digital literacy of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.</td>
<td>10 Digital Literacy Section Questions (See Appendix C)</td>
<td>Independent Sample t-Test, Mann-Whitney U Test</td>
</tr>
<tr>
<td>3. Describe the digital technology self-efficacy of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument.</td>
<td>33 Technology Self-Efficacy Section Questions (See Appendix C)</td>
<td>Independent Sample t-Test, Mann-Whitney U Test</td>
</tr>
<tr>
<td>4. Describe the digital technology self-efficacy of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument.</td>
<td>33 Technology Self-Efficacy Section Questions (See Appendix C)</td>
<td>Independent Sample t-Test, Mann-Whitney U Test</td>
</tr>
<tr>
<td>5. Describe the attitudes towards digital communication of pre-service agricultural teacher candidates enrolled at a specific land grant university using who have and have not participated in a virtual mentoring program using Aydin and Karaa’s (2013) Attitudes Toward Technology instrument.</td>
<td>17 Attitude Toward Section Questions (See Appendix C)</td>
<td>Independent Sample t-Test, Mann-Whitney U Test</td>
</tr>
<tr>
<td>6. Describe the attitudes towards digital communication of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using Aydin and Karaa’s (2013) Attitudes Toward Technology instrument.</td>
<td>17 Attitude Toward Technology Section Questions (See Appendix C)</td>
<td>Independent Sample t-Test, Mann-Whitney U Test</td>
</tr>
<tr>
<td>7. Compare Twitter usage, blogging usage, and video observation usage of pre-service agriculture teacher and in-service agriculture teacher populations who have and have not participated in a virtual mentoring program.</td>
<td>8 Technology Usage Section Questions (See Appendix C)</td>
<td>Chi-square Test</td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary

In Chapter three, I discussed the quantitative research methods used to guide this study and the research perspective that shaped it, explaining how the study population was selected through census and random sampling while providing information on the pre-service agriculture teacher study participants who had and had not participated in a virtual mentoring program, and on the in-service agriculture teacher participants who had and had not participated in a virtual mentoring program. In addition, chapter 3 shared information on how the survey instrument was developed using a combination of questions from Ng's (2012) Digital Literacy Skills instrument, Kabacki-Yurdakul et al.’s (2012) technology self-efficacy Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument, and Aydin and Karaa’s (2013) Attitudes Toward Technology instrument. Sample questions from each of the instruments were presented along with the response scale and response choices. Finally, chapter 3 focused on the three major threats to a survey instrument: error, reliability, and validity of the survey instrument, and how they were addressed. A description of how the reliability statistics for the instrument were calculated was presented along with the protocol for the pilot test and provided detail on survey administration protocols and how they were adapted due to the COVID-19 outbreak. Following the survey administration protocols was a description of how the survey instrument data were collected and coded, closing with a description of the data analysis methods used for each research objective.
CHAPTER 4

RESULTS

Chapter four describes the data analysis and findings for each of the seven research objectives that guide this study. For each of the seven objectives, descriptive and normality information will be shared, as will the results of tests used to compare survey respondents. Chapter four will begin with the presentation of response rate data. Demographic information about survey respondents will follow. Chapter four will close with a discussion of the findings for each of the seven research objectives of the study.

Purpose and Objectives

The purpose of the study was to describe the impact of virtual mentoring program participation on digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication for pre-service agricultural teacher candidates and in-service agricultural educators. The following research objectives guide the study:

1. Describe the digital literacy of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.
2. Describe the digital literacy of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.
3. Describe the digital technology self-efficacy of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument.

4. Describe the digital technology self-efficacy of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument.

5. Describe the attitudes towards digital communication of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using Aydin and Karaa’s (2013) Attitudes Toward Technology instrument.

6. Describe the attitudes towards digital communication of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using Aydin and Karaa’s (2013) Attitudes Toward Technology instrument.

7. Compare Twitter usage, blogging usage, and video observation usage of pre-service agriculture teacher and in-service agriculture teacher populations who have and have not participated in a virtual mentoring program.

**Data Analysis**

The survey responses were collected using Qualtrics. For the purpose of the study, a completed response is considered one that has 85% of the survey items answered (Brosnan,
Only completed survey responses were included for data analysis. A summary of total and complete survey responses is shown in Table 13.

Table 13

Summary of Survey Response Rates

<table>
<thead>
<tr>
<th>Item</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Surveys Received</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-Service Agriculture Teachers</td>
<td>100</td>
<td>64.5</td>
</tr>
<tr>
<td>Pre-Service Agriculture Teachers</td>
<td>53</td>
<td>70.7</td>
</tr>
<tr>
<td>Usable Surveys Received</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-Service Agriculture Teachers</td>
<td>90</td>
<td>58.1</td>
</tr>
<tr>
<td>Pre-Service Agriculture Teachers</td>
<td>52</td>
<td>69.3</td>
</tr>
<tr>
<td>Response Rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-Service Agriculture Teachers</td>
<td>90</td>
<td>58.1</td>
</tr>
<tr>
<td>Pre-Service Agriculture Teachers</td>
<td>52</td>
<td>69.3</td>
</tr>
</tbody>
</table>

Completed survey responses were exported to SPSS for data analysis. All statistical tests were run at the .05 alpha level. This confidence level was chosen because it is one of the most commonly used and accepted in social science survey research (Urdan, 2010). Using this alpha level reduces the risk of Type I error (Marin & Bridgmon, 2012).

Descriptive statistics were used to examine pre-service agriculture teacher and in-service agriculture teacher responses for normality. Frequencies were used for categorical variables from the survey instrument which included: type of agriculture teacher, virtual mentoring program participation, type of virtual mentoring program participation, Twitter usage, blogging usage, and video observation usage. Independent sample t-tests were used to compare the overall digital literacy, technology self-efficacy, and attitude toward technology between those who had and
had not participated in the virtual mentoring program for both pre-service agriculture teacher and in-service agriculture teacher respondents.

**Demographic Characteristics of Study Participants**

The study respondent population consisted of more individuals 58.2% (n=83) that had participated in the virtual mentoring program. The majority of study participants 73.9% (n=105), were regular Twitter users, while the minority 22.5% (n=32) regularly used blogging. The number of study participants who participated in video observation was nearly equal. A complete summary of demographic variables for overall study participants is shown in Table 14.

**Table 14**

*Summary of Demographic Variables: Overall Study Participants*

<table>
<thead>
<tr>
<th>Item</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of Agriculture Teacher</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-Service</td>
<td>90</td>
<td>63.3</td>
</tr>
<tr>
<td>Pre-Service</td>
<td>52</td>
<td>36.7</td>
</tr>
<tr>
<td><strong>Virtual Mentoring Program Participation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>83</td>
<td>58.2</td>
</tr>
<tr>
<td>No</td>
<td>59</td>
<td>41.8</td>
</tr>
<tr>
<td><strong>Twitter User</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>105</td>
<td>73.9</td>
</tr>
<tr>
<td>No</td>
<td>37</td>
<td>26.1</td>
</tr>
<tr>
<td><strong>Blogging Participant</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>32</td>
<td>22.5</td>
</tr>
<tr>
<td>No</td>
<td>110</td>
<td>77.5</td>
</tr>
<tr>
<td><strong>Video Observation Participant</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>67</td>
<td>47.2</td>
</tr>
<tr>
<td>No</td>
<td>75</td>
<td>52.8</td>
</tr>
</tbody>
</table>

*Note.* Some numbers in this table do not add to the total number of respondents due to individuals not answering survey instrument item.
The pre-service agriculture teacher study respondents were nearly equally split between those that had participated in the virtual mentoring program and those that had not participated in the virtual mentoring program. A large majority of pre-service agriculture teacher study participants 90.4% (n=47) were regular Twitter users, while blogging showed a nearly even split between users (55.8%, n=29) and non-users (42.3%, n=22). The majority of pre-service study participants 63.3% (n=33) did not engage in video observation. A complete summary of demographic variables for pre-service agriculture teacher participants is shown in Table 15.

**Table 15**

*Summary of Demographic Variables: Pre-Service Agriculture Teachers*

<table>
<thead>
<tr>
<th>Item</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Mentoring Program Participation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>27</td>
<td>51.9</td>
</tr>
<tr>
<td>No</td>
<td>25</td>
<td>48.1</td>
</tr>
<tr>
<td>Twitter User</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>47</td>
<td>90.4</td>
</tr>
<tr>
<td>No</td>
<td>4</td>
<td>7.7</td>
</tr>
<tr>
<td>Blogging Participant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>29</td>
<td>55.8</td>
</tr>
<tr>
<td>No</td>
<td>22</td>
<td>42.3</td>
</tr>
<tr>
<td>Type of Blogging Participation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Author Blog Posts</td>
<td>14</td>
<td>26.9</td>
</tr>
<tr>
<td>Leave Feedback on Blog Posts</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Both</td>
<td>7</td>
<td>13.5</td>
</tr>
<tr>
<td>Video Observation Participation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>18</td>
<td>34.6</td>
</tr>
<tr>
<td>No</td>
<td>33</td>
<td>63.3</td>
</tr>
<tr>
<td>Type of Video Observation Participation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Record and Upload Videos</td>
<td>5</td>
<td>9.6</td>
</tr>
<tr>
<td>Leave Feedback on Videos</td>
<td>6</td>
<td>11.5</td>
</tr>
<tr>
<td>Both</td>
<td>7</td>
<td>13.5</td>
</tr>
</tbody>
</table>

*Note.* Some numbers in this table do not add to the total number of respondents due to individuals not answering survey instrument item.
Of the in-service agriculture teacher study respondents, the majority 62.2% (n=56) had participated in the virtual mentoring program. The majority of in-service agriculture teacher study participants 64.4% (n=58), were regular Twitter users, while the minority 11.1% (n=10) regularly participated in blogging. Study participants who participated in video observation 54.4% (n=49), was slightly greater than study participants who did not engage in video observation 43% (n=39). A complete summary of demographic variables for overall in-service agriculture teacher participants is shown in Table 16.

Table 16

Summary of Demographic Variables: In-Service Teachers

<table>
<thead>
<tr>
<th>Item</th>
<th>Item</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Mentoring Program Participation</td>
<td>Yes</td>
<td>56</td>
<td>62.2</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>34</td>
<td>37.8</td>
</tr>
<tr>
<td>Twitter User</td>
<td>Yes</td>
<td>58</td>
<td>64.4</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>31</td>
<td>34.4</td>
</tr>
<tr>
<td>Blogging Participant</td>
<td>Yes</td>
<td>10</td>
<td>11.1</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>79</td>
<td>88.8</td>
</tr>
<tr>
<td>Type of Blogging Participation</td>
<td>Author Blog Posts</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>Leave Feedback on Blog Posts</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>Both</td>
<td>8</td>
<td>8.9</td>
</tr>
<tr>
<td>Video Observation Participation</td>
<td>Yes</td>
<td>49</td>
<td>54.4</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>39</td>
<td>43.3</td>
</tr>
<tr>
<td>Type of Video Observation Participation</td>
<td>Record and Upload Videos</td>
<td>6</td>
<td>6.7</td>
</tr>
<tr>
<td></td>
<td>Leave Feedback on Videos</td>
<td>23</td>
<td>25.6</td>
</tr>
<tr>
<td></td>
<td>Both</td>
<td>20</td>
<td>22.2</td>
</tr>
</tbody>
</table>

Note. Some numbers in this table do not add to the total number of respondents due to individuals not answering survey instrument item.
Findings for Research Objective 1

Research objective 1: Describe the digital literacy of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.

Summary of Descriptive Statistics

Descriptive statistics were run for each digital literacy survey item and overall digital literacy score for all pre-service agriculture teacher survey respondents. Means and standard deviations for each individual digital literacy survey item and overall digital literacy score for pre-service agriculture teachers who have and have not participated in the virtual mentoring program are shown in Table 17. For overall digital literacy score mean values of pre-service teachers who had participated in the virtual mentoring program, skewness (-.563) and kurtosis (.509) values and analysis of the histogram and normal Q-Q plot supported the normality assumption. For overall digital literacy score mean values of pre-service teachers who had not participated in the virtual mentoring program, skewness (-.43) and kurtosis (-.621) values and analysis of the histogram and normal Q-Q plot supported the normality assumption.
Table 17

*Pre-Service Agriculture Teacher Means and Standard Deviations of Digital Literacy Items*

<table>
<thead>
<tr>
<th>Item</th>
<th>Pre-Service Virtual Mentoring Program Participants</th>
<th>Pre-Service Non-Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>1. I know how to solve my own technical problems.</td>
<td>3.74</td>
<td>0.65</td>
</tr>
<tr>
<td>2. I can learn new technologies easily.</td>
<td>4.00</td>
<td>0.67</td>
</tr>
<tr>
<td>3. I keep up with important new technologies.</td>
<td>3.56</td>
<td>0.69</td>
</tr>
<tr>
<td>4. I know about a lot of different technologies.</td>
<td>3.59</td>
<td>0.69</td>
</tr>
<tr>
<td>5. I have the technical skills I need to use technology for learning and to create digital artifacts (e.g. presentations, digital stories, wikis, blogs) that demonstrate my understanding of what I have learned.</td>
<td>4.22</td>
<td>0.69</td>
</tr>
<tr>
<td>6. I have good technology skills.</td>
<td>3.93</td>
<td>0.47</td>
</tr>
<tr>
<td>7. I am confident with my search and evaluate skills in regard to obtaining information from the Web.</td>
<td>4.30</td>
<td>0.60</td>
</tr>
<tr>
<td>8. I am familiar with issues related to web-based activities e.g. cyber safety, search issues, plagiarism.</td>
<td>4.00</td>
<td>0.67</td>
</tr>
<tr>
<td>9. Technology enables me to collaborate better with my peers on project work and other learning activities.</td>
<td>3.93</td>
<td>0.61</td>
</tr>
<tr>
<td>10. I frequently obtain help with my work from my friends over the Internet e.g. through Skype, Facebook, Blogs.</td>
<td>3.52</td>
<td>1.01</td>
</tr>
<tr>
<td>Overall mean (Total Possible Score=50)</td>
<td>38.78</td>
<td>3.95</td>
</tr>
</tbody>
</table>

*Note.* 1=Strongly Disagree, 2=Disagree, 3=Neither Agree nor Disagree, 4=Agree, 5=Strongly Agree.
Independent Sample t-Test Results

An independent sample t-test was run for overall digital literacy score of pre-service agriculture teachers who had and had not participated in a virtual mentoring program. The assumptions of Levene's test were met and equal variances were assumed. The results of the t-test ($t(50) = -.484, p = .630$) showed no statistical significance for overall digital literacy score. The results of the independent sample t-test were confirmed by a Mann-Whitney U test ($p=.713$), which recommended retaining the null hypothesis that virtual mentoring program participation did not have a statistically significant effect on the overall digital literacy score of pre-service agriculture teachers.
Findings for Research Objective 2

Research objective 2: Describe the digital literacy of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.

Summary of Descriptive Statistics

Descriptive statistics were run for each digital literacy survey item and overall digital literacy score for all in-service agriculture teacher survey respondents. Means and standard deviations for each individual digital literacy survey item and overall digital literacy score for in-service agriculture teachers who have and have not participated in the virtual mentoring program are shown in Table 18. For overall digital literacy score mean values for in-service agriculture teachers who had participated in the virtual mentoring program, skewness (-.432) and kurtosis (.540) values and analysis of the histogram and normal Q-Q plot supported the normality assumption. For overall digital literacy score mean values for in-service agriculture teachers who had not participated in the virtual mentoring program, skewness (.449) and kurtosis (-.283) values and analysis of the histogram and normal Q-Q plot supported the normality assumption.
<table>
<thead>
<tr>
<th>Item</th>
<th>In-Service Virtual Mentoring Program Participants</th>
<th>In-Service Non-Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>1. I know how to solve my own technical problems.</td>
<td>3.93</td>
<td>0.71</td>
</tr>
<tr>
<td>2. I can learn new technologies easily.</td>
<td>4.11</td>
<td>0.73</td>
</tr>
<tr>
<td>3. I keep up with important new technologies.</td>
<td>3.79</td>
<td>0.84</td>
</tr>
<tr>
<td>4. I know about a lot of different technologies.</td>
<td>3.45</td>
<td>0.91</td>
</tr>
<tr>
<td>5. I have the technical skills I need to use technology for learning and to create digital artifacts (e.g. presentations, digital stories, wikis, blogs) that demonstrate my understanding of what I have learned.</td>
<td>3.77</td>
<td>0.89</td>
</tr>
<tr>
<td>6. I have good technology skills.</td>
<td>3.91</td>
<td>0.72</td>
</tr>
<tr>
<td>7. I am confident with my search and evaluate skills in regard to obtaining information from the Web.</td>
<td>4.39</td>
<td>0.52</td>
</tr>
<tr>
<td>8. I am familiar with issues related to web-based activities e.g. cyber safety, search issues, plagiarism.</td>
<td>4.04</td>
<td>0.57</td>
</tr>
<tr>
<td>9. Technology enables me to collaborate better with my peers on project work and other learning activities.</td>
<td>4.27</td>
<td>0.56</td>
</tr>
<tr>
<td>10. I frequently obtain help with my work from my friends over the Internet e.g. through Skype, Facebook, Blogs.</td>
<td>3.36</td>
<td>1.13</td>
</tr>
<tr>
<td>Overall Mean (Total Possible Score=50)</td>
<td>38.86</td>
<td>5.63</td>
</tr>
</tbody>
</table>
Independent Sample t-Test Results

An independent sample t-test was run for overall digital literacy score of in-service agriculture teachers who had and had not participated in a virtual mentoring program. The assumptions for Levene's test were met and equal variances were able to be assumed. The results of the independent sample t-test showed that there may be a statistically significant relationship ($t(88) = -2.469, p = .015$) between in-service agriculture teacher virtual mentoring program participation and overall digital literacy score. The results of the independent sample t-test were confirmed by a Mann-Whitney U test ($p = .006$), which recommended rejecting the null hypothesis that virtual mentoring program participation did not have a statistically significant effect on the overall digital literacy score of in-service agriculture teachers. A Cohen's-$d$ effect size test was performed and indicated that the effect size of 0.522 was considered moderate because it was between 0.25 and 0.75 (Urdan, 2010).
Findings for Research Objective 3

Research objective 3: Describe the digital technology self-efficacy of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument.

Summary of Descriptive Statistics

Descriptive statistics were run for each technology self-efficacy survey item and overall technology self-efficacy score for all pre-service agriculture teacher survey respondents. Means and standard deviations for each individual technology self-efficacy survey item and overall technology self-efficacy score for pre-service agriculture teachers who have and have not participated in the virtual mentoring program are shown in Table 19. For overall technology self-efficacy score mean values of pre-service agriculture teachers who had participated in a virtual mentoring program, skewness (-.025) and kurtosis (-.249) values and analysis of the histogram and normal Q-Q plot supported the normality assumption. For overall technology self-efficacy score mean values of pre-service agriculture teachers who had not participated in a virtual mentoring program, skewness (.558) and kurtosis (.124) values and analysis of the histogram and normal Q-Q plot supported the normality assumption.
Table 19

Pre-Service Agriculture Teacher Means and Standard Deviations of Technology Self-Efficacy Items

<table>
<thead>
<tr>
<th>Item</th>
<th>Pre-Service Virtual Mentoring Program Participants</th>
<th>Pre-Service Non-Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>1. I can update an instructional material (paper based, electronic or multimedia materials, etc.) based on the needs (students, environment, duration, etc.) by using technology.</td>
<td>4.11</td>
<td>0.57</td>
</tr>
<tr>
<td>2. I can use technology to determine students’ needs related to a content area in the pre-teaching process.</td>
<td>3.70</td>
<td>0.82</td>
</tr>
<tr>
<td>3. I can use technology to develop activities based on student needs to enrich the teaching and learning process.</td>
<td>4.07</td>
<td>0.73</td>
</tr>
<tr>
<td>4. I can plan the teaching and learning process according to available technological resources.</td>
<td>3.96</td>
<td>0.70</td>
</tr>
<tr>
<td>5. I can conduct a needs analysis for technologies to be used in the teaching and learning process to increase the quality of teaching.</td>
<td>3.63</td>
<td>0.92</td>
</tr>
<tr>
<td>6. I can optimize the duration of the lesson by using technologies (education software, virtual labs, etc.).</td>
<td>3.70</td>
<td>0.95</td>
</tr>
<tr>
<td>7. I can develop appropriate assessment tools by using technology.</td>
<td>4.00</td>
<td>0.62</td>
</tr>
<tr>
<td>8. I can combine appropriate methods, techniques, and technologies by evaluating their attributes in order to present the content effectively.</td>
<td>3.89</td>
<td>0.69</td>
</tr>
<tr>
<td>9. I can use technology to appropriately design materials to the needs for an effective teaching and learning process.</td>
<td>4.15</td>
<td>0.53</td>
</tr>
<tr>
<td>10. I can organize the educational environment in an appropriate way to use technology.</td>
<td>3.85</td>
<td>0.81</td>
</tr>
<tr>
<td>11. I can implement effective classroom management in the teaching and learning process in which technology is used.</td>
<td>3.56</td>
<td>0.89</td>
</tr>
<tr>
<td>12. I can assess whether students have the appropriate content knowledge by using technology.</td>
<td>3.78</td>
<td>0.80</td>
</tr>
<tr>
<td>13. I can apply instructional approaches and methods appropriate to individual differences with the help of technology.</td>
<td>3.59</td>
<td>0.97</td>
</tr>
<tr>
<td>14. I can use technology for implementing educational activities such as homework, projects, etc.</td>
<td>4.11</td>
<td>0.64</td>
</tr>
<tr>
<td>15. I can use technology-based communication tools (blog, forum, chat, e-mail, etc.) in the teaching process.</td>
<td>4.22</td>
<td>0.75</td>
</tr>
<tr>
<td>16. I can use technology for evaluation students’ achievement in related content areas.</td>
<td>4.04</td>
<td>0.70</td>
</tr>
<tr>
<td>17. I can be an appropriate model for the students in following codes of ethics for the use of technology in my teaching.</td>
<td>4.41</td>
<td>0.69</td>
</tr>
<tr>
<td>18. I can guide students in the process of designing technology-based products (presentations, games, films, etc.).</td>
<td>3.93</td>
<td>0.67</td>
</tr>
</tbody>
</table>
Table 19 (continued)

Pre-Service Agriculture Teacher Means and Standard Deviations of Technology Self-Efficacy Items

<table>
<thead>
<tr>
<th>Item</th>
<th>Pre-Service Virtual Mentoring Program Participants</th>
<th>Pre-Service Non-Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>19. I can use innovative technologies (Facebook, blogs, Twitter, podcasting, etc.) to support the teaching and learning process.</td>
<td>3.89</td>
<td>.934</td>
</tr>
<tr>
<td>20. I can use technology to update my knowledge and skills in the area that I will teach.</td>
<td>4.26</td>
<td>.594</td>
</tr>
<tr>
<td>21. I can update my technological knowledge for the teaching process.</td>
<td>4.22</td>
<td>.75</td>
</tr>
<tr>
<td>22. I can use technology to keep my content knowledge updated.</td>
<td>4.38</td>
<td>.63</td>
</tr>
<tr>
<td>23. I can provide each student equal access to technology.</td>
<td>3.52</td>
<td>1.15</td>
</tr>
<tr>
<td>24. I can behave ethically in acquiring and using special/private information which will be used in teaching a subject area via technology (audio records, video records, documents, etc.).</td>
<td>4.22</td>
<td>0.89</td>
</tr>
<tr>
<td>25. I can use technology in every phase of the teaching and learning process by considering copyright issues (e.g. license).</td>
<td>3.67</td>
<td>0.87</td>
</tr>
<tr>
<td>26. I can follow the teaching profession’s code of ethics in online educational environments (WebCT, Moodle, etc.).</td>
<td>4.07</td>
<td>0.78</td>
</tr>
<tr>
<td>27. I can provide guidance to students by leading them to valid and reliable digital sources.</td>
<td>4.22</td>
<td>0.57</td>
</tr>
<tr>
<td>28. I can behave ethically regarding the appropriate use of technology in educational environments.</td>
<td>4.30</td>
<td>0.77</td>
</tr>
<tr>
<td>29. I can troubleshoot problems that could be encountered with online educational environments (WebCT, Moodle, etc.).</td>
<td>3.56</td>
<td>1.01</td>
</tr>
<tr>
<td>30. I can troubleshoot any kind of problem that may occur while using technology in any phase of the teaching-learning process.</td>
<td>3.38</td>
<td>1.02</td>
</tr>
<tr>
<td>31. I can use technology to find solutions to problems (structuring, updating relating the content to real life, etc.).</td>
<td>3.96</td>
<td>0.43</td>
</tr>
<tr>
<td>32. I can become a leader in spreading the use of technological innovations in my teaching community.</td>
<td>3.63</td>
<td>0.96</td>
</tr>
<tr>
<td>33. I can cooperate with other disciplines regarding the use of technology to solve problems encountered in the process of presenting content.</td>
<td>3.85</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Overall Mean (Total Possible Score=165)  
129.59 | 17.39 | 123.48 | 17.88 

Note. 1=Strongly Disagree, 2=Disagree, 3=Neither Agree nor Disagree, 4=Agree, 5=Strongly Agree.
Independent Sample t-Test Results

An independent sample *t*-test was run for overall technology self-efficacy score of pre-service agriculture teachers who had and had not participated in a virtual mentoring program. The assumptions of Levene's test were met and equal variances were assumed. The results of the *t*-test (*t*(50) = -1.240, *p* = .220) showed no statistical significance for overall technology self-efficacy score. The results of the independent sample *t*-test were confirmed by a Mann-Whitney U test (*p* = .150), which recommended retaining the null hypothesis that virtual mentoring program participation did not have a statistically significant effect on the overall technology self-efficacy score of pre-service agriculture teachers.
Findings for Research Objective 4

Research objective 4: Describe the digital technology self-efficacy of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument.

Summary of Descriptive Statistics

Descriptive statistics were run for each technology self-efficacy survey item and overall technology self-efficacy score for all in-service agriculture teacher survey respondents. Means and standard deviations for each individual technology self-efficacy survey item and overall technology self-efficacy score for in-service agriculture teachers who have and have not participated in the virtual mentoring program are shown in Table 20. For overall technology self-efficacy score mean values for in-service agriculture teachers who had participated in the virtual mentoring program, skewness (-.697) and kurtosis (2.115) values and analysis of the histogram and normal Q-Q plot supported the normality assumption. For overall technology self-efficacy score mean values for in-service agriculture teachers who had not participated in the virtual mentoring program, skewness (.838) and kurtosis (.581) values and analysis of the histogram and normal Q-Q plot supported the normality assumption.
Table 20

*In-Service Agriculture Teacher Means and Standard Deviations of Technology Self-Efficacy Items*

<table>
<thead>
<tr>
<th>Item</th>
<th>In-Service Virtual Mentoring Program Participants</th>
<th>In-Service Non-Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>1. I can update an instructional material (paper based, electronic or multimedia materials, etc.) based on the needs (students, environment, duration, etc.) by using technology.</td>
<td>4.27</td>
<td>6.18</td>
</tr>
<tr>
<td>2. I can use technology to determine students’ needs related to a content area in the pre-teaching process.</td>
<td>3.69</td>
<td>0.85</td>
</tr>
<tr>
<td>3. I can use technology to develop activities based on student needs to enrich the teaching and learning process.</td>
<td>4.00</td>
<td>0.68</td>
</tr>
<tr>
<td>4. I can plan the teaching and learning process according to available technological resources.</td>
<td>4.04</td>
<td>0.83</td>
</tr>
<tr>
<td>5. I can conduct a needs analysis for technologies to be used in the teaching and learning process to increase the quality of teaching.</td>
<td>3.29</td>
<td>0.88</td>
</tr>
<tr>
<td>6. I can optimize the duration of the lesson by using technologies (education software, virtual labs, etc.).</td>
<td>3.96</td>
<td>0.78</td>
</tr>
<tr>
<td>7. I can develop appropriate assessment tools by using technology.</td>
<td>4.04</td>
<td>0.78</td>
</tr>
<tr>
<td>8. I can combine appropriate methods, techniques, and technologies by evaluating their attributes in order to present the content effectively.</td>
<td>4.00</td>
<td>0.78</td>
</tr>
<tr>
<td>9. I can use technology to appropriately design materials to the needs for an effective teaching and learning process.</td>
<td>4.09</td>
<td>0.66</td>
</tr>
<tr>
<td>10. I can organize the educational environment in an appropriate way to use technology.</td>
<td>4.00</td>
<td>0.76</td>
</tr>
<tr>
<td>11. I can implement effective classroom management in the teaching and learning process in which technology is used.</td>
<td>3.89</td>
<td>0.70</td>
</tr>
<tr>
<td>12. I can assess whether students have the appropriate content knowledge by using technology.</td>
<td>3.88</td>
<td>0.76</td>
</tr>
<tr>
<td>13. I can apply instructional approaches and methods appropriate to individual differences with the help of technology.</td>
<td>3.71</td>
<td>0.84</td>
</tr>
<tr>
<td>14. I can use technology for implementing educational activities such as homework, projects, etc.</td>
<td>4.11</td>
<td>0.67</td>
</tr>
<tr>
<td>15. I can use technology-based communication tools (blog, forum, chat, e-mail, etc.) in the teaching process.</td>
<td>4.11</td>
<td>0.75</td>
</tr>
<tr>
<td>16. I can use technology for evaluation students’ achievement in related content areas.</td>
<td>3.96</td>
<td>0.71</td>
</tr>
<tr>
<td>17. I can be an appropriate model for the students in following codes of ethics for the use of technology in my teaching.</td>
<td>4.34</td>
<td>0.79</td>
</tr>
<tr>
<td>18. I can guide students in the process of designing technology-based products (presentations, games, films, etc.).</td>
<td>3.71</td>
<td>0.98</td>
</tr>
</tbody>
</table>
Table 20 (continued)

*In-Service Agriculture Teacher Means and Standard Deviations of Technology Self-Efficacy Items*

<table>
<thead>
<tr>
<th>Item</th>
<th>In-Service Virtual Mentoring Program Participants</th>
<th>In-Service Non-Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>19. I can use innovative technologies (Facebook, blogs, Twitter, podcasting, etc.) to support the teaching and learning process.</td>
<td>3.75</td>
<td>0.89</td>
</tr>
<tr>
<td>20. I can use technology to update my knowledge and skills in the area that I will teach.</td>
<td>4.43</td>
<td>0.53</td>
</tr>
<tr>
<td>21. I can update my technological knowledge for the teaching process.</td>
<td>4.20</td>
<td>0.48</td>
</tr>
<tr>
<td>22. I can use technology to keep my content knowledge updated.</td>
<td>4.25</td>
<td>0.61</td>
</tr>
<tr>
<td>23. I can provide each student equal access to technology.</td>
<td>3.33</td>
<td>1.07</td>
</tr>
<tr>
<td>24. I can behave ethically in acquiring and using special/private information which will be used in teaching a subject area via technology (audio records, video records, documents, etc.).</td>
<td>4.41</td>
<td>0.62</td>
</tr>
<tr>
<td>25. I can use technology in every phase of the teaching and learning process by considering copyright issues (e.g. license).</td>
<td>3.82</td>
<td>0.81</td>
</tr>
<tr>
<td>26. I can follow the teaching profession’s code of ethics in online educational environments (WebCT, Moodle, etc.).</td>
<td>4.13</td>
<td>0.77</td>
</tr>
<tr>
<td>27. I can provide guidance to students by leading them to valid and reliable digital sources.</td>
<td>4.15</td>
<td>0.62</td>
</tr>
<tr>
<td>28. I can behave ethically regarding the appropriate use of technology in educational environments.</td>
<td>4.55</td>
<td>0.50</td>
</tr>
<tr>
<td>29. I can troubleshoot problems that could be encountered with online educational environments (WebCT, Moodle, etc.).</td>
<td>3.55</td>
<td>0.93</td>
</tr>
<tr>
<td>30. I can troubleshoot any kind of problem that may occur while using technology in any phase of the teaching-learning process.</td>
<td>3.58</td>
<td>0.91</td>
</tr>
<tr>
<td>31. I can use technology to find solutions to problems (structuring, updating relating the content to real life, etc.).</td>
<td>4.07</td>
<td>0.63</td>
</tr>
<tr>
<td>32. I can become a leader in spreading the use of technological innovations in my teaching community.</td>
<td>3.67</td>
<td>0.81</td>
</tr>
<tr>
<td>33. I can cooperate with other disciplines regarding the use of technology to solve problems encountered in the process of presenting content.</td>
<td>4.04</td>
<td>0.60</td>
</tr>
</tbody>
</table>

**Overall Mean (Total Possible Score=165)**

<table>
<thead>
<tr>
<th></th>
<th>In-Service Virtual Mentoring Program Participants</th>
<th>In-Service Non-Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Overall Mean</td>
<td>130.30</td>
<td>17.05</td>
</tr>
</tbody>
</table>

*Note.* 1=Strongly Disagree, 2=Disagree, 3=Neither Agree nor Disagree, 4=Agree, 5=Strongly Agree.
Independent Sample t-Test Results

An independent sample t-test was run for overall technology self-efficacy score of in-service agriculture teachers who had and had not participated in the virtual mentoring program. The results of the independent sample t-test are shown in Table 21. The assumptions for Levene's test were met and equal variance was assumed. Based on the results of the independent sample t-test, there may be a significant relationship ($t(88) = -2.030, p = .045$) between in-service agriculture teacher virtual mentoring program participation and overall technology self-efficacy score. The results of the independent sample t-test were confirmed by a Mann-Whitney U test ($p = .009$), which recommended rejecting the null hypothesis that virtual mentoring program participation did not have a statistically significant effect on the overall technology self-efficacy score of in-service agriculture teachers. A Cohen's-$d$ effect size test was performed and indicated that the effect size of 0.43 was considered moderate because it is between 0.25 and 0.75 (Urdan, 2010).
Findings for Research Objective 5

Research objective 5: Describe the attitudes towards digital communication of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using Aydin and Karaa’s (2013) Attitudes Toward Technology instrument.

Summary of Descriptive Statistics

Descriptive statistics were run for each attitude toward technology survey item and overall attitude toward technology score for all pre-service agriculture teacher survey respondents. Means and standard deviations for each individual attitude toward technology survey item and overall attitude toward technology score for pre-service agriculture teachers who have and have not participated in the virtual mentoring program are shown in Table 21. For overall attitude toward technology score mean values for pre-service agriculture teachers who had participated in the virtual mentoring program, skewness (-.405) and kurtosis (1.993) values and analysis of the histogram and normal Q-Q plot supported the normality assumption. For overall attitude toward technology score mean values for pre-service agriculture teachers who had not participated in the virtual mentoring program, skewness (.047) and kurtosis (1.024) values and analysis of the histogram and normal Q-Q plot supported the normality assumption.
### Table 21

*Pre-Service Agriculture Teacher Means and Standard Deviations of Attitude Toward Technology Items*

<table>
<thead>
<tr>
<th>Item</th>
<th>Pre-Service Virtual Mentoring Program Participants</th>
<th>Pre-Service Non-Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>1. I believe that technology improves the efficiency of work.</td>
<td>3.89</td>
<td>0.84</td>
</tr>
<tr>
<td>2. I like to use technology.</td>
<td>3.81</td>
<td>0.87</td>
</tr>
<tr>
<td>3. I closely follow the work on technology.</td>
<td>2.89</td>
<td>0.93</td>
</tr>
<tr>
<td>4. I'm interested in technology research.</td>
<td>2.67</td>
<td>1.00</td>
</tr>
<tr>
<td>5. I believe in the necessity of technology for a better quality of life.</td>
<td>3.63</td>
<td>0.79</td>
</tr>
<tr>
<td>6. Learning technology is fun.</td>
<td>3.56</td>
<td>0.89</td>
</tr>
<tr>
<td>7. I encourage people to use technology.</td>
<td>3.89</td>
<td>0.69</td>
</tr>
<tr>
<td>8. I like to learn about technological developments.</td>
<td>3.41</td>
<td>1.01</td>
</tr>
<tr>
<td>9. Learning the technological developments is an extra burden for me.</td>
<td>2.67</td>
<td>1.07</td>
</tr>
<tr>
<td>10. I like to buy books and magazines about technology.</td>
<td>1.93</td>
<td>0.87</td>
</tr>
<tr>
<td>11. I'd like to have a job in technology.</td>
<td>1.89</td>
<td>0.84</td>
</tr>
<tr>
<td>12. I'm tired of reading about new developments in technology.</td>
<td>2.63</td>
<td>1.14</td>
</tr>
<tr>
<td>13. I'm interested in learning interesting information about technology.</td>
<td>3.30</td>
<td>0.99</td>
</tr>
<tr>
<td>14. I like technology to be useful to me in daily life.</td>
<td>4.00</td>
<td>0.83</td>
</tr>
<tr>
<td>15. Every citizen should understand technology.</td>
<td>3.85</td>
<td>0.66</td>
</tr>
<tr>
<td>16. I spend my free time learning more about technology.</td>
<td>2.11</td>
<td>0.75</td>
</tr>
<tr>
<td>17. I inform those in my surroundings about the use of technology in everyday life.</td>
<td>3.04</td>
<td>0.98</td>
</tr>
<tr>
<td>Overall Mean (Total Possible Score=85)</td>
<td>53.15</td>
<td>7.76</td>
</tr>
</tbody>
</table>
Independent Sample t-Test

An independent sample t-test was run for overall attitude toward technology score of pre-service agriculture teachers who had and had not participated in a virtual mentoring program. The assumptions for Levene's test were met and equal variance was assumed. Although the Levene's test statistic was acceptable (> .05), the results of the t-test ($t(50) = - .82, p = .935$) showed no statistical significance for overall attitude toward technology score. The results of the independent sample t-test were confirmed by a Mann-Whitney U test ($p = .583$), which recommended retaining the null hypothesis that virtual mentoring program participation did not have a statistically significant effect on the overall attitude toward technology score of pre-service agriculture teachers.
Findings for Research Objective 6

Research objective 6: Describe the attitudes towards digital communication of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using Aydin and Karaa’s (2013) Attitudes Toward Technology instrument.

Summary of Descriptive Statistics

Descriptive statistics were run for each attitude toward item and overall attitude toward technology score for all in-service agriculture teacher survey respondents. Means and standard deviations for each individual attitude toward technology survey item and overall attitude toward technology score for in-service agriculture teachers who have and have not participated in the virtual mentoring program are shown in Table 2. For overall attitude toward technology score mean values of in-service agriculture teachers who had participated in the virtual mentoring program, skewness (.436) and kurtosis (2.563) values and analysis of the histogram and normal Q-Q plot supported the normality assumption. For overall attitude toward technology score mean values of in-service agriculture teachers who had not participated in the virtual mentoring program, skewness 1.105) and kurtosis (1.771) values and analysis of the histogram and normal Q-Q plot supported the normality assumption.
### Table 22

**In-Service Agriculture Teacher Means and Standard Deviations of Attitude Toward Technology Items**

<table>
<thead>
<tr>
<th>Item</th>
<th>In-Service Virtual Mentoring Program Participants</th>
<th>In-Service Non-Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
<td><em>M</em></td>
<td><em>SD</em></td>
</tr>
<tr>
<td>1. I believe that technology improves the efficiency of work.</td>
<td>4.22</td>
<td>0.59</td>
</tr>
<tr>
<td>2. I like to use technology.</td>
<td>4.09</td>
<td>0.77</td>
</tr>
<tr>
<td>3. I closely follow the work on technology.</td>
<td>3.24</td>
<td>1.05</td>
</tr>
<tr>
<td>4. I'm interested in technology research.</td>
<td>2.85</td>
<td>0.91</td>
</tr>
<tr>
<td>5. I believe in the necessity of technology for a better quality of life.</td>
<td>3.65</td>
<td>0.90</td>
</tr>
<tr>
<td>6. Learning technology is fun.</td>
<td>3.71</td>
<td>0.78</td>
</tr>
<tr>
<td>7. I encourage people to use technology.</td>
<td>3.98</td>
<td>0.65</td>
</tr>
<tr>
<td>8. I like to learn about technological developments.</td>
<td>3.60</td>
<td>0.87</td>
</tr>
<tr>
<td>9. Learning the technological developments is an extra burden for me.</td>
<td>2.83</td>
<td>1.06</td>
</tr>
<tr>
<td>10. I like to buy books and magazines about technology.</td>
<td>1.82</td>
<td>0.81</td>
</tr>
<tr>
<td>11. I'd like to have a job in technology.</td>
<td>1.91</td>
<td>0.94</td>
</tr>
<tr>
<td>12. I'm tired of reading about new developments in technology.</td>
<td>2.60</td>
<td>0.71</td>
</tr>
<tr>
<td>13. I'm interested in learning interesting information about technology.</td>
<td>3.38</td>
<td>0.75</td>
</tr>
<tr>
<td>14. I like technology to be useful to me in daily life.</td>
<td>4.20</td>
<td>0.62</td>
</tr>
<tr>
<td>15. Every citizen should understand technology.</td>
<td>3.87</td>
<td>0.84</td>
</tr>
<tr>
<td>16. I spend my free time learning more about technology.</td>
<td>2.44</td>
<td>0.91</td>
</tr>
<tr>
<td>17. I inform those in my surroundings about the use of technology in everyday life.</td>
<td>3.25</td>
<td>0.94</td>
</tr>
</tbody>
</table>

*Overall Mean (Total Possible Score=85)*

<table>
<thead>
<tr>
<th><strong>Overall Mean</strong></th>
<th><strong>M</strong></th>
<th><strong>SD</strong></th>
<th><strong>M</strong></th>
<th><strong>SD</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>55.60</strong></td>
<td><strong>7.61</strong></td>
<td><strong>56.27</strong></td>
<td><strong>1.59</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* 1=Strongly Disagree, 2=Disagree, 3=Neither Agree nor Disagree, 4=Agree, 5=Strongly Agree.
Independent Sample t-Test Results

An independent sample $t$-test was run for overall attitude toward technology score of in-service agriculture teachers who had and had not participated in a virtual mentoring program. The assumptions for Levene's test were met and equal variances were assumed. The results of the $t$-test ($t(87) = -.446, p = .657$) showed no statistical significance for overall attitude toward technology score. The results of the independent sample $t$-test were confirmed by a Mann-Whitney U test ($p=.976$), which recommended retaining the null hypothesis that virtual mentoring program participation did not have a statistically significant effect on overall attitude toward technology score for in-service agriculture teachers.
Findings for Research Objective 7

Research objective 7: Compare Twitter usage, blogging usage, and video observation usage of pre-service agriculture teacher and in-service agriculture teacher populations who have and have not participated in a virtual mentoring program.

Pre-Service Teachers

Chi-square tests were run to see if there was a relationship between pre-service agriculture teacher virtual mentoring program participation and usage of Twitter, blogging, and video observation. When pre-service agriculture teachers were not Twitter users, 16.7% did not participate in the virtual mentoring program, and 0% participated in the virtual mentoring program. When pre-service teachers were Twitter users, 83.3% did not participate in the virtual mentoring program, and 100% did participate in the virtual mentoring program. There was a significant column difference between Twitter users because their subscripts were different in the first two rows of the data set. Because all assumptions were met, a Pearson Chi-square test was used. The results of this test, \( \chi^2(1) = 4.883, \ p < 0.05, \) show that there is a statistically significant relationship between Twitter usage and virtual mentoring program participation of pre-service teachers. When examining the standardized residuals, type of Twitter user, yes or no, did not contribute more to the Chi-square test because both of their values were between -1.96 and +1.96. The relationship between Twitter usage and virtual mentoring program participation has a Cramer's V value of .309. This indicates a moderate effect size.
When pre-service agriculture teachers were not blogging users, 66.7% did not participate in the virtual mentoring program, and 48.1% participated in the virtual mentoring program. When pre-service teachers were blogging users, 33.3% did not participate in the virtual mentoring program, and 51.9% did participate in the virtual mentoring program. There was not a significant column difference between blogging users because their subscripts were the same in the first two rows of the data set. Because all assumptions were met, a Pearson Chi-square test was used. The results of this test, $\chi^2(1) = 1.776$, $p > 0.05$, show that there is not a statistically significant relationship between blogging usage and virtual mentoring program participation of pre-service teachers. When examining the standardized residuals, type of blogging user, yes or no, did not contribute more to the Chi-square test because both of their values were between -1.96 and +1.96. The relationship between blogging usage and virtual mentoring program participation has a Cramer's V value of 0.187. This indicates a weak effect size.

When pre-service agriculture teachers were not video observation users, 75.0% did not participate in the virtual mentoring program, and 55.6% participated in the virtual mentoring program. When pre-service teachers were video observation users, 25.0% did not participate in the virtual mentoring program, and 44.4% did participate in the virtual mentoring program. There was a not significant column difference between video observation users because their subscripts were the same in the first two rows of the data set. Because all assumptions were met, a Pearson Chi-square test was used. The results of this test, $\chi^2(1) = 2.104$, $p > 0.05$, show that there is a not statistically significant relationship between video observation usage and virtual mentoring program participation of pre-service teachers. When examining the standardized residuals, type of video observation user, yes or no, did not contribute more to the Chi-square test because both of their values were between -1.96 and +1.96. The relationship between video
observation usage and virtual mentoring program participation has a Cramer's V value of .203. This indicates a moderate effect size.

*In-Service Teachers*

When in-service agriculture teachers were not Twitter users, 60.6% did not participate in the virtual mentoring program, and 19.6% participated in the virtual mentoring program. When in-service teachers were Twitter users, 39.4% did not participate in the virtual mentoring program, and 80.4% did participate in the virtual mentoring program. There was a significant column difference between Twitter users because their subscripts were different in the first two rows of the data set. Because all assumptions were met, a Pearson Chi-square test was used. The results of this test, $\chi^2(1) = 15.349$, $p < 0.05$, show that there is a statistically significant relationship between Twitter usage and virtual mentoring program participation of in-service teachers. When examining the standardized residuals, not using Twitter contributed more to the Chi-square test because its values were outside of the range of -1.96 to +1.96. The relationship between Twitter usage and virtual mentoring program participation has a Cramer's V value of .415. This indicates a moderate effect size.

When in-service agriculture teachers were not blogging users, 90.9% did not participate in the virtual mentoring program, and 87.5% participated in the virtual mentoring program. When in-service teachers were blogging users, 9.1% did not participate in the virtual mentoring program, and 12.5% did participate in the virtual mentoring program. There was not a significant column difference between blogging users because their subscripts were the same in the first two rows of the data set. Because all assumptions were met, a Pearson Chi-square test was used. The
results of this test, $\chi^2(1) = .242$, $p > 0.05$, show that there is not a statistically significant relationship between blogging usage and virtual mentoring program participation of in-service teachers. When examining the standardized residuals, type of blogging user, yes or no, did not contribute more to the Chi-square test because both of their values were between -1.96 and +1.96. The relationship between blogging usage and virtual mentoring program participation has a Cramer's V value of .052. This indicates a very weak effect size.

When in-service agriculture teachers were not video observation users, 62.5% did not participate in the virtual mentoring program, and 33.9% participated in the virtual mentoring program. When in-service teachers were video observation users, 37.5% did not participate in the virtual mentoring program, and 66.1% did participate in the virtual mentoring program. There was a significant column difference between video observation users because their subscripts were different in the first two of the data set. Because all assumptions were met, a Pearson Chi-square test was used. The results of this test, $\chi^2(1) = 6.736$, $p < 0.05$, show that there is a statistically significant relationship between video observation usage and virtual mentoring program participation of in-service teachers. When examining the standardized residuals, type of video observation user, yes or no, did not contribute more to the Chi-square test because both of their values were between -1.96 and +1.96. The relationship between video observation usage and virtual mentoring program participation has a Cramer's V value of .277. This indicates a moderate effect size.
Summary

Chapter four discussed and shared the findings of data analysis for all seven of the research objectives. Chapter four began with a summary of survey respondents and response rates. Chapter four then presented general demographic summary information for all survey participants and more detailed demographic summaries for pre-service agriculture teacher respondents and in-service agriculture teacher respondents. There was not a statistically significant difference for overall digital literacy score, overall technology self-efficacy score, and attitude toward technology for pre-service agriculture teachers who had participated in a virtual mentoring program and pre-service agriculture teachers who had not participated in a virtual mentoring program. There was a statistically significant difference for overall digital literacy score and overall technology self-efficacy score for in-service agriculture teachers who had participated in a virtual mentoring program and in-service agriculture teachers who had not participated in a virtual mentoring program. There was not a statistically significant difference for overall technology self-efficacy score for in-service agriculture teachers who had participated in a virtual mentoring program and in-service agriculture teachers who had not participated in a virtual mentoring program. There were statistically significant relationships between pre-service agriculture teacher virtual mentoring program participation and Twitter usage, and in-service agriculture teacher virtual mentoring program participation and Twitter and video observation usage.
Chapter five presents the conclusions, implications, and recommendations for each of the seven research objectives that guided the study. Figure 10 depicts an overview of study findings that are discussed in chapter five. Chapter five shares limitations of the study that may have impacted the findings and broad-scale implications and recommendations for future research.

Figure 10

Summary of Study Findings

Purpose and Objectives

The purpose of the study was to describe the impact of virtual mentoring program participation on digital literacy behaviors, digital technology self-efficacy levels, and attitudes
towards digital communication for pre-service agricultural teacher candidates and in-service agricultural educators. The following research objectives guide the study:

1. Describe the digital literacy of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.

2. Describe the digital literacy of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.

3. Describe the digital technology self-efficacy of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument.

4. Describe the digital technology self-efficacy of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument.

5. Describe the attitudes towards digital communication of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using Aydin and Karaa’s (2013) Attitudes Toward Technology instrument.

6. Describe the attitudes towards digital communication of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using Aydin and Karaa’s (2013) Attitudes Toward Technology instrument.
7. Compare Twitter usage, blogging usage, and video observation usage of pre-service agriculture teacher and in-service agriculture teacher populations who have and have not participated in a virtual mentoring program.

**Research Objective One**

Describe the digital literacy of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.

There was not a significant difference in overall digital literacy levels of pre-service agriculture teachers who had and had not participated in a virtual mentoring program. However, pre-service agriculture teachers, regardless of virtual mentoring program participation indicated high levels of overall digital literacy.

**Discussion**

Pre-service agriculture teachers that participated in the study indicated high levels of digital literacy, regardless of virtual mentoring program participation, which supports the recommendations of Ata and Yıldırım (2019) and Ng (2012) that suggest that pre-service teachers learn how to use digital skills in practice and formal course settings, and that digital literacy development is beneficial when incorporated into pre-service teacher coursework. Students in the agriculture teacher preparation program at The Pennsylvania State University use a wide variety of educational technology throughout their coursework as part of an approach to
help them develop digital literacy skills. Students are required to learn how to use many different
technology tools that they may be asked to use in the classroom and are provided with best
practices for how to use them. The use of this approach may have led to the findings that align
with those from Ng's (2012) study: pre-service teachers perceived having improved their digital
literacy through explicit teaching and learning about educational technologies and their
integration into their learning.

The agriculture teacher preparation program at The Pennsylvania State University already
incorporates Ata and Yıldırım’s (2019) suggestion of using practical activities to aid in the
development of digital literacy of pre-service teachers. Throughout the teacher preparation
coursework, students are able to practice different digital literacy skills by participating in
activities such as demonstration lessons, microteaching, and the virtual mentoring program. Pre-
service agriculture teachers also experience the usage of digital communication platforms
commonly used in education as part of the majority of their coursework. Ng found that courses
that use this approach had a positive impact on students in terms of the digital literacy skills
required to create content with digital tools and ability to solve technical issues (2012). The
findings from the study align with this, because pre-service teachers who regularly used digital
communication tools as part of their coursework indicated higher levels of digital literacy.

Implications and Recommendations

Ata and Yıldırım (2019) and Ng (2012) recommended that digital literacy development
be incorporated into pre-service teacher coursework. They suggest pre-service teachers
experience real-world situations related to digital literacy usage in the classroom as part of their
coursework. This approach is already being successfully used with the pre-service agriculture teachers at The Pennsylvania State University, who experience educational technology usage and digital literacy skill development throughout the majority of their teacher preparation coursework. It is recommended that this approach be examined by other agriculture teacher preparation programs to see how they can restructure their coursework to incorporate digital literacy skill development.

Because re-writing the curriculum for teacher education coursework takes time, a short-term solution could be to develop and use supplemental online modules designed to aid in increased knowledge of digital literacy and digital literacy skill development. The modules could be designed in a similar fashion to those used for other online professional development trainings, such as those used by OSHA, and can be delivered free-of-charge. Using an approach and format similar to online professional development trainings that in-service agriculture teachers participate in as part of their professional responsibilities also align with Ata and Yıldırım's (2019) suggestion that pre-service teachers can receive benefit from experiencing real-world situations related to digital literacy usage in the classroom.

Ng (2012) found that pre-service teachers perceived having improved their digital literacy through explicit teaching and learning about educational technologies and their integration into their learning. The pre-service agriculture teachers who participated in the study, regardless of virtual mentoring program participation, were from an agriculture teacher preparation program that placed an emphasis on educational technology usage throughout its coursework. It is recommended that the digital literacy skills section of the survey instrument be administered to pre-service agriculture teachers enrolled in a similar teacher preparation program at another university. Their results could be compared to those of the pre-service agriculture
teachers who had participated in the virtual mentoring program to see if a difference exists in overall digital literacy levels.

**Research Objective 2**

Describe the digital literacy of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using Ng’s (2012) Digital Literacy Skills instrument.

In-service agriculture teachers who had participated in the virtual mentoring program exhibited statistically significantly higher overall digital literacy levels than in-service agriculture teachers who had not participated in the virtual mentoring program.

**Discussion**

In-service agriculture teachers who participated in the virtual mentoring program were chosen because of their ability to exhibit the characteristics of a digitally-literate teacher: ability to use technology to improve teaching, familiarity with technology tools, a positive attitude towards the use of technology in teaching practices, and development of adequate technical skills to use different forms of educational technology (Güneş & Bahçivan, 2018). The virtual mentoring program incorporated the different steps involved in becoming a digitally literate teacher. The steps included mastering the technical and operational skills to use information communication technology for learning and in everyday activities that are part of the teaching and learning process (Ng, 2012).
The virtual mentors used three main digital tools to communicate with their assigned mentee: Twitter, blogging, and video observation. The mentors were provided with a series of trainings and support documents to help them learn how to use the different digital communication platforms used in the virtual mentoring program as part of the program onboarding process. A designated digital coach at The Pennsylvania State University was assigned to support the virtual mentors throughout their year of service and was available to address their questions and concerns and provide individualized training and help sessions. Such practices are in accordance with Li et al. (2015) who suggested that teachers benefit when they have support to scaffold the use of classroom technology in the field and to increase their development of technology behaviors.

Some of the common digital literacy behaviors required for teachers to successfully teach and learn with technology include the ability to use basic information and communication technology skills and the application of more advanced skills regarding the creative and critical use of digital tools (Sefton-Green, Nixon, & Erstad, 2009). The mentors were able to demonstrate their mastery of such behaviors by effectively engaging in regular digital communication with their mentees using Twitter, blogging, and video observation. The mentors used the digital communication platforms in critical and creative fashions as they interacted with their mentees to leave feedback, answer questions, and demonstrate best practices for teaching and learning with technology.
Implications and Recommendations

The in-service agriculture teachers who participated in the virtual mentoring program demonstrated higher digital literacy levels than in-service agriculture teachers who did not participate in the program. Because teachers benefit from support to increase their development of technology behaviors (Li et al., 2015), it would be beneficial to explore how virtual mentoring relationships could be established between in-service agriculture teachers with advanced digital literacy skillsets and those who wish to improve their digital literacy levels. The digital communication platforms of Twitter, blogging, and video observation were successfully used for the virtual mentoring program examined in the study. It would be beneficial to speak with in-service agriculture teachers who participated in the virtual mentoring program to gain their input on whether these same platforms would be appropriate to use for virtual mentoring relationships between agriculture teachers, or if there are other platforms that may be more useful to aid in the development of digital literacy skill development.

In-service agriculture teachers who volunteered to participate in the virtual mentoring program either directly communicated their willingness to participate in the program or were recommended by another agriculture teacher. Mentors were given the opportunity to serve another term as a mentor at the end of their year of service and to suggest others that they felt would be quality virtual mentors. This approach allowed for the snowball effect to occur and created hybrid vigor within the population of potential virtual mentors.

However, this strategy would not be a useful way to survey all of the agriculture teachers who may wish to participate in a peer virtual mentoring relationship centered on digital literacy skill development. To reach as many agriculture teachers as possible, it could be beneficial to network with state and national organizations to access their member lists and obtain teacher
contact information. An online survey instrument, similar to the one used in this study, could be
developed and used to solicit information from agriculture teachers interested in participating in
the virtual mentoring program. Teachers could indicate if they were willing to serve as a mentor
or if they wanted to be mentored and would respond Ng's (2012) digital literacy behavior
statements to determine their baseline digital literacy levels. Their responses to specific behavior
statements could help to identify targeted areas where they were seeking improvement and could
be used to help match them with suitable mentors who indicated high levels of proficiency in
those areas.

**Research Objective 3**

Describe the digital technology self-efficacy of pre-service agricultural teacher candidates
enrolled at a specific land grant university who have and have not participated in a virtual
mentoring program using the Technological Pedagogical Content Knowledge Scale
(TPACK-Deep) instrument.

There was not a significant difference in overall digital literacy levels of pre-service
agriculture teachers who had and had not participated in a virtual mentoring program.

**Discussion**

Pre-service agriculture teachers who participated in the virtual mentoring program
exhibited higher overall technology self-efficacy scores than those pre-service agriculture
teachers who had not participated in the virtual mentoring program. This finding aligns with the
work of Lemon and Garvis (2016), who examined the perceived levels of pre-service teachers’ self-efficacy in teaching with technology. They found that those pre-service teachers who had access to coursework on how to incorporate and use educational technology had higher perceived levels of technology self-efficacy than those pre-service teachers who had not had access to that type of coursework. Virtual mentoring program participation was built into the methods of teaching agriculture course that all pre-service agriculture teacher virtual mentoring program participants had completed prior to participating in the study. The course included content on how to incorporate and use educational technology for teaching and learning practices.

Kao and Tsai (2009) proposed that pre-service teachers with competent technology self-efficacy skills may have a greater chance of success in technology-related tasks related to teaching and learning practices. Teachers who possess higher technology self-efficacy skills have been found to accept new learning ideas more easily and are usually more willing to try various teaching methods using technology to provide students with different learning experiences (Chen & Tseng, 2012). Pre-service agriculture teachers who had participated in the virtual mentoring program were given the opportunity to practice using education technology for different teaching scenarios such as microteaching, demonstrations, and labs. Such experiences could have been related to the higher technology self-efficacy levels reported by pre-service agriculture teacher virtual mentoring program participants.
Teachers’ self-efficacy is consistently and strongly related to their usage of technology in their teaching and learning practices (Kao, Tsai, & Shih, 2014). The pre-service agriculture teachers who participated in the study, regardless of virtual mentoring program participation, were from an agriculture teacher preparation program that placed an emphasis on educational technology usage throughout its coursework. They indicated relatively high levels of overall technology self-efficacy in their responses to the survey instrument, which could be related to their experiences in the teacher preparation program. To determine if this were the case, it is recommended that more detailed information be gathered from pre-service agriculture teacher participants related their perceptions of technology self-efficacy development. This could be done by administering an additional survey instrument that contained open-ended questions to collect qualitative data, or through focus group interviews with participants. Information gathered could be used to help determine best practices for how technology self-efficacy skill development can be incorporated into teacher preparation coursework.

Pre-service teachers who have access to coursework on how to incorporate and use educational technology have higher perceived levels of technology self-efficacy than those pre-service teachers who have not had access to that type of coursework (Lemon & Garvis, 2016). The pre-service agriculture teachers who participated in the study, regardless of virtual mentoring program participation, were from an agriculture teacher preparation program that placed an emphasis on educational technology usage throughout its coursework. It is recommended that the technology self-efficacy skills section of the survey instrument be administered to pre-service agriculture teachers enrolled in a similar teacher preparation program at another university. Their results could be compared to those of the pre-service agriculture
teachers who had participated in the virtual mentoring program to see if a difference exists in overall technology self-efficacy levels.

Research Objective 4

Describe the digital technology self-efficacy of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using the Technological Pedagogical Content Knowledge Scale (TPACK-Deep) instrument.

In-service agriculture teachers who had participated in the virtual mentoring program exhibited statistically significantly higher overall technology self-efficacy levels than in-service agriculture teachers who had not participated in the virtual mentoring program.

Discussion

The findings of the study support Hatlevik and Hatlevik's (2018) claims that technology self-efficacy is affected by vicarious experiences, such as mentoring and feedback from others who have a significant impact on their teaching practices. They also support additional findings from the same study, which showed that teachers prefer to develop digital competence and technology self-efficacy through collaboration with other teachers and that such relationships can have substantial associations with technology self-efficacy for instructional purposes and the use of technology during instruction. (Hatlevik & Hatlevik, 2018). In the virtual mentoring program, in-service agriculture teachers regularly communicated and collaborated with their pre-service
agriculture teacher mentor and the other in-service agriculture teachers who were also part of the mentee’s mentoring team.

Teachers’ self-efficacy has been identified as an important variable that is related to their use of technology and is consistently and strongly related to their usage of technology in their teaching and learning practices (Pynoo et al., 2011, Kao; Tsai, & Shih, 2014). Teachers with higher technology-related self-efficacy have increased inclinations to use technology in their teaching and learning practices (Paraskeva et al., 2008). The in-service agriculture teachers who participated in the virtual mentoring program were selected to serve as mentors because they had previously demonstrated use of technology in their teaching and learning practices.

**Implications and Recommendations**

The in-service agriculture teachers who participated in the virtual mentoring program demonstrated higher technology self-efficacy levels than in-service agriculture teachers who did not participate in the program. A 2018 study by Hatlevik and Hatlevik found that teachers prefer to develop digital competence and technology self-efficacy through collaboration with other teachers, and that their technology self-efficacy can be affected by vicarious experiences, such as mentoring, and feedback from others who have a significant impact on their teaching practices. Based on these findings, it would be beneficial to explore how virtual mentoring relationships could be established between in-service agriculture teachers with high levels of technology self-efficacy and those who wish to improve their technology self-efficacy.

Research has shown a positive relationship between self-efficacy related to using digital tools and the use of technology for teaching purposes (Teo, 2011). The digital communication
platforms of Twitter, blogging, and video observation were successfully used for the virtual mentoring program examined in the study. It would be beneficial to speak with in-service agriculture teachers who participated in the virtual mentoring program to gain their input on whether these same platforms would be appropriate to use for virtual mentoring relationships between agriculture teachers, or if there are other platforms that may be more useful to aid in the development of technology self-efficacy.

In-service agriculture teachers who volunteered to participate in the virtual mentoring program either directly communicated their willingness to participate in the program or were recommended by another agriculture teacher. Mentors were given the opportunity to serve another term as a mentor at the end of their year of service and to suggest others that they felt would be quality virtual mentors. This approach allowed for the snowball effect to occur and created hybrid vigor within the population of potential virtual mentors.

However, this strategy would not be a useful way to survey all of the agriculture teachers who may wish to participate in a peer virtual mentoring relationship centered around digital literacy skill development. To reach as many agriculture teachers as possible, it could be beneficial to network with state and national organizations to access their member lists and obtain teacher contact information. An online survey instrument, similar to the one used in this study, could be developed and used to solicit information from agriculture teachers interested in participating in the virtual mentoring program. Teachers could indicate if they were willing to serve as a mentor or if they wanted to be mentored and would respond to Kabakci-Yurdakul et al.'s (2012) Technological Pedagogical Content Knowledge Scale (TPACK-Deep) technology self-efficacy skill statements to determine their baseline technology self-efficacy levels. Their responses to specific behavior statements could help to identify targeted areas where they were
seeking improvement and could be used to help match them with suitable mentors who indicated high levels of proficiency in those areas.

**Research Objective 5**

Describe the attitudes towards digital communication of pre-service agricultural teacher candidates enrolled at a specific land grant university who have and have not participated in a virtual mentoring program using Aydin and Karaa’s (2013) Attitudes Toward Technology instrument.

There was not a significant difference in overall attitude toward levels of pre-service agriculture teachers who had and had not participated in a virtual mentoring program. While the pre-service teacher attitude toward technology scores were not extremely high, they were higher than those of in-service agriculture teacher participants.

**Discussion**

The findings of the study may support the findings of Mitchell, Wohleb, & Skinner (2016) who reported that years in the profession is an influencer for attitude toward technology, with those educators who are newer to the profession being more likely to utilize educational technology than those who have been in the classroom for a longer period of time. The pre-service agriculture teachers who participated in the study, regardless of virtual mentoring program participation, had experienced the usage of educational technology in the classroom as a student, and were asked to regularly use it for both personal and professional purposes for much
of their lives. Teachers who are more familiar with educational technology uses and who have a positive attitude towards it, are more likely to use it as part of their coursework and classroom practices (Bai & Ertner, 2008). The pre-service agriculture teachers who participated in the study, regardless of virtual mentoring program participation, all had experienced the usage of educational technology as part of their teacher preparation coursework.

The COVID-19 outbreak required pre-service agriculture teachers to switch from in-person classroom instruction to digital instruction with little to no warning (Tatum, 2020). Reid (2017) found that how educators experience the different items related to technology adoption, such as training, hardware/software support, and updates, can contribute to positive or negative perceptions of educational technology usage for in-person and virtual instruction. Because the pre-service agriculture teachers who had participated in the study, regardless of virtual mentoring program participation, had prior experience with using different types of educational technology as part of their teacher preparation coursework, they had experienced some training and support with learning how to use the different tools involved in virtual instruction. Such experiences aligned with recommendations from Kao et al. (2014), which suggested that finding effective ways to improve teachers’ perceptions of engaging in interaction in online learning activities and their capacity to use technology-related teaching methods in the classroom had the potential to enhance and improve their attitudes towards technology usage.

**Implications and Recommendations**

Attitudes towards technology of pre-service teachers can be influenced by their comfort level with using educational technology (Reid, 2017). The pre-service agriculture teachers who
participated in this study all used educational technology on a regular basis as part of their teacher preparation coursework, and this may have increased their attitude toward technology levels. Participants, regardless of virtual mentoring program participation, were impacted by the transition to virtual instruction due to the COVID-19 pandemic shortly before the survey instrument was administered. To determine if the transition to virtual instruction and the usage of educational technology on a regular basis as part of their teacher preparation coursework impacted their attitude toward technology responses, it would be beneficial to administer the attitude toward technology skills section of the survey instrument to pre-service agriculture teachers enrolled in a similar teacher preparation program at another university during a time when regular, in-person instruction was occurring. The results could be compared to those of the pre-service agriculture teachers who had participated in the virtual mentoring program to see if a difference exists in overall attitude toward technology levels.

Ata and Yıldırım (2019) found that one of the issues related to teacher attitudes towards the use of digital technologies was having the necessary active teaching strategies to incorporate it into their teaching and learning practices. Pre-service agriculture teachers who participated in the study all had some level of instruction in how to incorporate technology into their teaching and learning practices as part of their teacher preparation coursework. To determine how such experiences impacted their attitude toward technology, it is recommended that more detailed information be gathered from pre-service agriculture teacher participants related their attitude toward technology development. This could be done by administering an additional survey instrument that contained open-ended questions to collect qualitative data, or through focus group interviews with participants. Information gathered could be used to help determine best
practices for how developing a positive attitude toward technology can be incorporated into teacher preparation coursework.

**Research Objective 6**

Describe the attitudes towards digital communication of in-service agriculture teachers from several different states who have and have not participated in a virtual mentoring program using Aydin and Karaa’s (2013) Attitudes Toward Technology instrument.

Although the difference was not statistically significant, in-service agriculture teachers who participated in the virtual mentoring program had higher overall attitude toward technology scores than in-service agriculture teachers who did not participate in the virtual mentoring program. This same group of teachers also had a statistically significantly higher overall technology self-efficacy scores.

**Discussion**

Teacher attitude towards educational technology plays a significant role as to whether they will choose to use it for personal and professional practice. The findings from the study align with those of (Pamuk & Peker, 2009), which found that teachers’ attitudes towards technology are positively correlated with their technology self-efficacy. The findings also correlate with a study conducted by Kao and Tsai (2009) that found that teachers with greater technology self-efficacy may have more positive attitudes toward using technology in their teaching and learning practices.
Reid (2017) found that how educators experience the different items related to technology adoption, such as training, hardware/software support, and updates can contribute to positive or negative perceptions of the educational technology usage. This was also noted by Ata and Yıldırım (2019) who found that one of the issues related to teacher attitudes towards the use of digital technologies was having the necessary active teaching strategies to incorporate it into their teaching and learning practices. In-service agriculture teachers who participated in the virtual mentoring program were provided with a series of trainings and support documents to help them learn how to use the different digital communication platforms used in the virtual mentoring program as part of the program onboarding process. A designated digital coach at The Pennsylvania State University was assigned to support the virtual mentors throughout their year of service and was available to address their questions and concerns and provide individualized training and help sessions.

Kao et al. (2014) found that teachers’ ability to use digital tools can also be a significant factor used to predict their participation in professional development related to attitude toward technology. The virtual mentors used three main digital tools to communicate with their assigned mentee: Twitter, blogging, and video observation. Together, the mentors and mentees engaged in digital professional development experiences such as a summer book club, completing collaborative tasks related to educational technology usage in the classroom, and sharing feedback, advice, and resources with one another.

There are a variety of factors that influence an educator’s attitude towards technology. The most common of these factors are individual and personal preferences, beliefs, and comfort levels in how pedagogy, content, and technology mix (Reid, 2017). The COVID-19 outbreak required agriculture teachers to switch from in-person classroom instruction to digital instruction
with little to no warning (Tatum, 2020). Depending on the school district in which they taught, agriculture teachers may have received little to no training on how to use the technology needed for virtual instruction or the best ways to mix pedagogy, content, and technology to allow for it to occur (Tatum, 2020).

Implications and Recommendations

In-service agriculture teacher study participants, regardless of virtual mentoring program participation, were impacted by the transition to virtual instruction due to the COVID-19 pandemic shortly before the survey instrument was administered. To determine if the transition to virtual instruction impacted their attitude toward technology responses, it would be beneficial to administer the attitude toward technology skills section of the survey instrument to in-service agriculture teachers who had not participated in the virtual mentoring program during a time when regular, in-person instruction was occurring. The results could be compared to those of the in-service agriculture teachers who had participated in the virtual mentoring program to see if a difference exists in overall attitude toward technology levels.

Ata and Yıldırım (2019) found that one of the issues related to teacher attitudes towards the use of digital technologies was having the necessary active teaching strategies to incorporate it into their teaching and learning practices. In-service agriculture teacher virtual mentors who participated in the study all had some level of instruction in how to incorporate technology into their teaching and learning practices as part of their onboarding process for the virtual mentoring program. To determine how such experiences impacted their attitude toward technology, it is recommended that more detailed information be gathered from the virtual mentors related their
attitude toward technology development. This could be done by administering an additional survey instrument that contained open-ended questions to collect qualitative data, or through focus group interviews with participants. Information gathered could be used to help shape and start professional discussions for what can be done assist in-service agriculture teachers in developing a positive attitude toward technology.

**Research Objective 7**

**Compare Twitter usage, blogging usage, and video observation usage of pre-service agriculture teacher and in-service agriculture teacher populations who have and have not participated in a virtual mentoring program.**

There was a significant relationship between virtual mentoring program participation and Twitter usage for pre-service agriculture teachers. There was also a significant relationship between virtual mentoring program participation and Twitter and video observation usage for in-service agriculture teachers.

**Discussion**

Digital communication technology has been shown to help enhance the educational technology usage of teachers at all stages of their career and can be used as a forum for professional communication to help expand teaching and learning beyond the classroom (Ebner et al., 2010). Participating in online professional learning communities hosted on digital communication platforms can provide teachers with opportunities to build relationships and learn
from each other and can enable them to improve their proficiency with digital communication technology usage (Wenger, 2007; Paulsen et al., 2015). Gunawardena et al. (2009), found participation in online professional learning communities can result in increased social interaction among users after participating in sharing of ideas, resources, and knowledge. Twitter can be useful in generating professional discourse in online professional learning communities, such as that of the virtual mentoring program. Twitter allows members of online professional learning communities to become efficient creators and consumers of the information contained in the Tweets they read and generate (Wesley, 2013). Findings from the study show that there was a relationship between Twitter usage and virtual mentoring program participation for both pre-service and in-service agriculture teachers. Pre-service agriculture teachers who participated in the virtual mentoring program authored Tweets, which their virtual mentors responded to. This information is supported by Colwell and Hutchinson’s (2018) study that found that using Twitter is an efficient way for teachers to bring information and questions to the attention of others who might be interested in the same topic, or who may be able to respond with helpful information.

Findings from the study support Murphrey et al.’s (2014) claim that recording teaching episodes and uploading them to an electronic observation platform is a valuable tool for teachers. Video observation was an important component of the virtual mentoring program, and in-service agriculture teachers left feedback on videos uploaded by their mentees. Video observation is widely used by in-service agriculture teachers, regardless of their virtual mentoring program participation status and supports findings that this practice is becoming more commonplace in the classroom (Reese, 2016).
Implications and Recommendations

Paulsen et al. (2015) explored the use of online professional learning communities with pre-service agriculture teachers and found it to be very helpful in connecting with other agricultural educators. The pre-service agriculture teachers who participated in the virtual mentoring program got to participate in an online professional learning community that allowed them to gain experience with digital communication platforms that they may be asked to use upon entering the classroom, such as social media, reflection tools, and video observation. However, it was found that even though the pre-service agriculture teachers were asked to use Twitter, blogging, and video observation on a regular basis as part of participation in the virtual mentoring program, there was only a relationship between program participation and Twitter usage. To begin to determine why there was only a relationship for Twitter usage, it is recommended that more detailed information be gathered from the pre-service teachers related how they were using blogging and video observation as part of the virtual mentoring program and if they differed from the way Twitter was being used. This could be done by administering an additional survey instrument that contained open-ended questions to collect qualitative data, or through focus group interviews with participants. Information gathered could be used to help determine how the usage of blogging and video observation in the virtual mentoring program may need to be altered to encourage pre-service agriculture teachers to use them more often, or how their usage can be made to be more purposeful.

There was a relationship between in-service teacher virtual mentoring program participation and Twitter and video observation usage, but not with blogging. As such, it would be useful to gather more information regarding if blogging is a relevant tool to include as part of the online professional learning community in the virtual mentoring program, or if there is
another platform that can be used to take its place. It would also be helpful to gather more information on how Twitter and video observation are being used in the classroom to help ensure that their use in the virtual mentoring program accurately reflects such practices. This could be done by administering an additional survey instrument that contained open-ended type questions to collect qualitative data from in-service teachers about how Twitter, blogging, and video observation are being used in professional practice, or through focus group interviews that would collect information on what digital tools are being used for reflective practice.

**Limitations of Research**

One of the limitations of this study was the size of the participant response groups of pre-service agriculture teachers and in-service agriculture teachers. While overall response rates for these populations were acceptable, the groups were not equal for those who had and had not participated in a virtual mentoring program. This was especially true for in-service agriculture teachers, where virtual mentoring participants had a far higher response rate then non-virtual mentoring participants. Such small sample sizes could have contributed to low statistical power for the tests that were run on the data. Small sample sizes could also have contributed to Type II error, and possible false negative results (Urdan, 2010).

Another limitation for this dissertation study was that all of the pre-service agriculture teacher participants were from the same agriculture teacher preparation program. The program encourages students to start using Twitter and blogging as part of their intro level coursework. Once pre-service agriculture teachers reach their junior year, usage of these platforms is required as part of course participation. During their final year in the program, usage of Twitter and
blogging are incorporated into the implementation of the virtual mentoring program and are the primary means of digital communication and reflection used by pre-service agriculture during their teaching methods course and their student teaching internship.

Video observation is also introduced to all pre-service agriculture teachers during their 100-level introductory agricultural education course. In this course, students practice recording and uploading a teaching episode and leaving feedback for their classmates. However, pre-service agriculture teachers do not use this tool again until their methods of teaching course in their final year of the program, when they are required to record and upload weekly teaching episodes and engage in regular peer feedback, as well as in feedback with their virtual mentoring teams. Pre-service agriculture teachers also upload monthly teaching episodes during their student teaching internship and engage in feedback with their virtual mentoring teams.

An additional limitation of this study was that all of the in-service agriculture teachers who had not participated in a virtual mentoring program were from the same state. As such, they may face similar challenges when using educational technology due to hardware and connectivity issues in their classrooms. The survey instrument was not sent to all in-service agriculture teachers in the state in which it was conducted. The in-service agriculture teachers that participated in this study were chosen at random and sending the survey to all teachers may have led to a higher response rate.

A final limitation to this study was that the survey instrument was sent to participants shortly after the COVID-19 pandemic struck and agriculture teachers were forced to switch to virtual instruction. While this aided in increasing response rates due to teachers regularly checking their email and having easy access to the survey instrument, it may have led to increased feelings of frustration related to technology usage. Many teachers were unfamiliar with
best practices for virtual instruction and how to use the technology needed to implement it. This may have caused both pre-service agriculture teachers and in-service agriculture teachers to respond more negatively to survey instrument items than they would have under normal circumstances. Concurrently, the transition to virtual instruction could have caused both pre-service agriculture teachers and in-service agriculture teachers to respond more positively to the survey instrument items if they were feeling successful about technology usage on the day they completed they survey.

**Recommendations to Further the Line of Inquiry**

The digital communication tools of Twitter, blogging, and video observation can be helpful tools for agriculture teachers to use to communicate with each other, as evidenced in the virtual mentoring program examined as part of this study. Study findings suggest that there are significant and important relationships between virtual mentoring program participation and digital communication platform usage of pre-service and in-service agriculture teachers. However, it is not known if or how the usage of each of the three platforms of interest: Twitter, blogging, and video observation, impact the TPACK behaviors of digital literacy, technology self-efficacy, and attitude toward technology. As such, it is recommended that a series of studies be conducted to examine the effect of usage of the three digital communication platforms, Twitter, blogging, and video observation, on the overall digital literacy, technology self-efficacy, and attitude toward technology scores of pre-service agriculture teachers and in-service agriculture teachers. A conceptual framework to support this potential study is shown in Figure 11.
Summary

Chapter five presented the conclusions, implications, and recommendations for each of the seven research objectives that guided the study. Chapter five also shared limitations of the study that may have impacted the findings. Broad scale implications for the study challenged agricultural education leaders and agriculture teacher educators to develop appropriate and beneficial tools and materials to assist pre-service and in-service agriculture teachers in developing digital literacy and technology self-efficacy skills, and a positive attitude toward technology. Chapter five closed with recommendations for future research, which included examining if there is a relationship between Twitter, blogging, and video observation usage and digital literacy, technology self-efficacy, and attitude toward technology.
REFERENCES


Tatum, A. (2020). Facing a crisis: "We're doing all we can to support our teachers". *The Learning Professional, 41*(2), 9.


APPENDIX A: STUDY IRB APPLICATION
EXEMPTION DETERMINATION

Date: August 13, 2019
From: Brigitt Leitzell,
To: Tiffany Morey

<table>
<thead>
<tr>
<th>Type of Submission:</th>
<th>Initial Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title of Study:</td>
<td>Virtual Mentoring In Agricultural Education: Describing Digital Literacy, Technology Self-Efficacy, and Attitudes Towards Technology</td>
</tr>
<tr>
<td>Principal Investigator:</td>
<td>Tiffany Morey</td>
</tr>
<tr>
<td>Study ID:</td>
<td>STUDY00013037</td>
</tr>
<tr>
<td>Submission ID:</td>
<td>STUDY00013037</td>
</tr>
<tr>
<td>Funding:</td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>
| Documents Approved: | • Dissertation IRB Instrument.docx (0.01), Category: Data Collection Instrument  
                        • Dissertation IRB.pdf (0.03), Category: IRB Protocol |

The Office for Research Protections determined that the proposed activity, as described in the above-referenced submission, does not require formal IRB review because the research met the criteria for exempt research according to the policies of this institution and the provisions of applicable federal regulations.

Continuing Progress Reports are not required for exempt research. Record of this research determined to be exempt will be maintained for five years from the date of this notification. If your research will continue beyond five years, please contact the Office for Research Protections closer to the determination end date.

Changes to exempt research only need to be submitted to the Office for Research Protections in limited circumstances described in the below-referenced Investigator Manual. If changes are being considered and there are questions about whether IRB review is needed, please contact the Office for Research Protections.

Penn State researchers are required to follow the requirements listed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within CATS IRB (http://irb.psu.edu).

This correspondence should be maintained with your records.

We would like to know how the IRB Program can better serve you. Please fill out our survey; it should take about a minute: https://www.research.psu.edu/irb/feedback.
Dear [Name of Pre-Service Agricultural Educator],

I hope you are having a great spring semester. At Penn State, we work hard as a team to provide you with a world-class agricultural teacher education program, but we can only do that with your feedback and help! We believe that society and technological demands on teachers (and teacher candidates) are moving at a rapid rate. Because of this, I have chosen to study "Virtual Mentoring in Agricultural Education: Describing Digital Literacy, Technology Self-Efficacy, and Attitudes Towards Technology of Pre-Service and In-Service Agricultural Educators" for my dissertation study. It is my hope that by working with you and collecting your feedback, we can help continue the Teach Ag Penn State legacy of excellence.

With rapid technological development, the need for in-service and pre-service teachers to have the knowledge, skills and strategies to integrate tools and platforms effectively is ever present. Digital literacy, technology self-efficacy, and attitude towards technology affect teachers’ ability to meaningfully transfer skills between personal to professional use, including purposeful integration into teaching and learning experiences, and influence how educators use technology, their comfort level with technology, and their willingness to use technology in teaching and learning practices. My research involves examining the digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication of pre-service agricultural teacher candidates and in-service agricultural educators who have and have not participated in a virtual mentoring program.

Part of the data collection process for my study includes having a pre-service agriculture teacher review my survey instrument for face validity (does the instrument appear to be measuring what it is intended to measure?).

Since all of the pre-service agriculture teachers here at PSU are part of my study, they are unable to serve in this role. As such, I was wondering if you would be willing to agree to serve as my pre-service agriculture teacher expert for the face validity portion of my dissertation.

To evaluate face validity, I will conduct a short Zoom video conference with you while you complete the survey instrument on Qualtrics. As you complete the survey instrument, I will ask you to share your thoughts about its appearance, format, and appropriateness, along with any other feedback you wish to provide. I will be taking field notes during our video interview, and the information you share will only be used to help me refine the instrument to make sure that it is measuring what it is supposed to be measuring!
The entire process should take about half an hour and will be conducting whenever it is most convenient for you. I would like to conduct your interview by the end of next week, if possible. I am available this Friday after 3:30, and any time next week.

Please let me know if you would be willing to assist me, and if so what times would work best for you for the interview. From there, I will schedule the meeting and send you a Zoom link.

Thank you and I look forward to hearing from you!

The Institutional Review Board of The Pennsylvania State University approves this study for use of human subjects: PSU IRB # 13037. If you have any questions, please contact me. We truly appreciate your time and assistance in conducting research.

Yours Sincerely,

Tiffany Morey

Ph.D. Candidate in Agricultural and Extension Education
Graduate Assistant for The Center for Professional Personnel Development
The Pennsylvania State University
012 Ferguson Building
Department of Agricultural Economics, Sociology and Education
University Park, PA 16802
Email: tgm23@psu.edu
Phone: 609-204-0819
Date: March 5, 2020

Dear [Name of In-Service Agricultural Educator],

I hope you are having a great spring semester with your agricultural education program and FFA chapters! At Penn State, we work hard as a team to provide agricultural educators with high quality professional development materials and opportunities, but we can only do that with your feedback and help! We believe that society and technological demands of teachers are moving at a rapid rate. Because of this, I have chosen to study "Virtual Mentoring in Agricultural Education: Describing Digital Literacy, Technology Self-Efficacy, and Attitudes Towards Technology of Pre-Service and In-Service Agricultural Educators" for my dissertation study. It is my hope that by working with you and collecting your feedback, we can help can continue the Teach Ag Penn State legacy of excellence.

With rapid technological development, the need for in-service and pre-service teachers to have the knowledge, skills and strategies to integrate tools and platforms effectively is ever present. Digital literacy, technology self-efficacy, and attitude towards technology affect teachers’ ability to meaningfully transfer skills between personal to professional use, including purposeful integration into teaching and learning experiences, and influence how educators use technology, their comfort level with technology, and their willingness to use technology in teaching and learning practices. My research involves examining the digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication of pre-service agricultural teacher candidates and in-service agricultural educators who have and have not participated in a virtual mentoring program.

Part of the data collection process for my study includes having an in-service agriculture teacher review my survey instrument for face validity (does the instrument appear to be measuring what it is intended to measure?).

Since all of the in-service agriculture teachers here in Pennsylvania are part of my study, they are unable to serve in this role. As such, I was wondering if you would be willing to agree to serve as my in-service agriculture teacher expert for the face validity portion of my dissertation.

To evaluate face validity, I will conduct a short Zoom video conference with you while you complete the survey instrument on Qualtrics. As you complete the survey instrument, I will ask you to share your thoughts about its appearance, format, and appropriateness, along with any other feedback you wish to provide. I will be taking field notes during our video interview, and
the information you share will only be used to help me refine the instrument to make sure that it is measuring what it is supposed to be measuring!

The entire process should take about half an hour and will be conducting whenever it is most convenient for you. I would like to conduct your interview by the end of next week, if possible. I am available this Friday after 3:30, and any time next week.

Please let me know if you would be willing to assist me, and if so what times would work best for you for the interview. From there, I will schedule the meeting and send you a Zoom link.

Thank you and I look forward to hearing from you!

The Institutional Review Board of The Pennsylvania State University approves this study for use of human subjects: PSU IRB # 13037. If you have any questions, please contact me. We truly appreciate your time and assistance in conducting research.

Yours Sincerely,

Tiffany Morey

Ph.D. Candidate in Agricultural and Extension Education
Graduate Assistant for The Center for Professional Personnel Development
The Pennsylvania State University
012 Ferguson Building
Department of Agricultural Economics, Sociology and Education
University Park, PA 16802
Email: tgm23@psu.edu
Phone: 609-204-0819
Survey Instrument Pilot Test Recruitment Letter: In-Service Agriculture Teachers

Date: March 11, 2020

Dear [Name of In-Service Agricultural Educator],

I hope you are having a great spring semester with your agricultural education program and FFA chapters! At Penn State, we work hard as a team to provide agricultural educators with high quality professional development materials and opportunities. We believe that society and technological demands of teachers are moving at a rapid rate. Because of this, I have chosen to study "Virtual Mentoring in Agricultural Education: Describing Digital Literacy, Technology Self-Efficacy, and Attitudes Towards Technology of Pre-Service and In-Service Agricultural Educators" for my dissertation study.

With rapid technological development, the need for in-service and pre-service teachers to have the knowledge, skills and strategies to integrate tools and platforms effectively is ever present. Digital literacy, technology self-efficacy, and attitude towards technology affect teachers’ ability to meaningfully transfer skills between personal to professional use, including purposeful integration into teaching and learning experiences, and influence how educators use technology, their comfort level with technology, and their willingness to use technology in teaching and learning practices. My research involves examining the digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication of pre-service agricultural teacher candidates and in-service agricultural educators who have and have not participated in a virtual mentoring program.

Part of the data collection process for my study includes having in-service agriculture teachers complete a pilot test of my survey instrument so that I can determine its reliability (does the instrument consistently measure what it is supposed to measure and does it produce similar results under consistent conditions?). A pilot test is conducted to examine data collection instruments in preparation for a larger study and is used to identify potential problem areas and deficiencies in the research instruments prior to implementation during the full study.

Since all of the in-service agriculture teachers here in Pennsylvania are part of my study, they are unable to serve in this role. As such, I was wondering if you would be willing to agree to complete my survey instrument so that I can calculate reliability for it.

To complete the survey instrument, please click on the link below. Your responses to the survey instrument will only be used to help me determine if it is producing similar results under consistent conditions and will not be included as part of my study data analysis, or shared with anyone else.
Follow this link to the Survey: ${l://SurveyLink?d=Take the Survey}

Or copy and paste the URL below into your Internet browser:
${l://SurveyURL}

Follow the link to opt out of future emails: ${l://OptOutLink?d=Click here to unsubscribe}

This link is uniquely tied to this survey and your email address. Please do not forward this message.

Completion of the survey instrument should take no more than 10-15 minutes of your time, and can be done on the device of your choice.

The Institutional Review Board of The Pennsylvania State University approves this study for use of human subjects: PSU IRB # 13037. If you have any questions, please contact me.

Thank you for your assistance in my dissertation data collection process!

Yours Sincerely,

Tiffany Morey

Ph.D. Candidate in Agricultural and Extension Education
Graduate Assistant for The Center for Professional Personnel Development
The Pennsylvania State University
012 Ferguson Building
Department of Agricultural Economics, Sociology and Education
University Park, PA 16802
Email: tgm23@psu.edu
Phone: 609-204-0819
Survey Instrument Pilot Test Follow-Up Letter: In-Service Agriculture Teachers

Date: March 16, 2020

Dear [Name of In-Service Agricultural Educator],

Now, more than ever, the technological demands of teachers are moving at a rapid rate as we navigate the waters of virtual instruction. Because of this, I have chosen to study "Virtual Mentoring in Agricultural Education: Describing Digital Literacy, Technology Self-Efficacy, and Attitudes Towards Technology of Pre-Service and In-Service Agricultural Educators" for my dissertation study.

With rapid technological development, the need for in-service and pre-service teachers to have the knowledge, skills and strategies to integrate tools and platforms effectively is ever present. Digital literacy, technology self-efficacy, and attitude towards technology affect teachers’ ability to meaningfully transfer skills between personal to professional use, including purposeful integration into teaching and learning experiences, and influence how educators use technology, their comfort level with technology, and their willingness to use technology in teaching and learning practices. My research involves examining the digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication of pre-service agricultural teacher candidates and in-service agricultural educators who have and have not participated in a virtual mentoring program.

At Penn State, we work hard as a team to provide agricultural educators with high quality professional development materials and opportunities. It is my hope that the results of my dissertation study will help us develop resources and programming to assist agricultural educators at all stages of their career in developing best practices for teaching and learning with technology and for the delivery of effective virtual instruction to their students.

Part of the data collection process for my study includes having in-service agriculture teachers complete a pilot test of my survey instrument so that I can determine its reliability (does the instrument consistently measure what it is supposed to measure and does it produce similar results under consistent conditions?). A pilot test is conducted to examine data collection instruments in preparation for a larger study and is used to identify potential problem areas and deficiencies in the research instruments prior to implementation during the full study.

Since all of the in-service agriculture teachers here in Pennsylvania are part of my study, they are unable to serve in this role. As such, I was wondering if you would be willing to agree to complete my survey instrument so that I can calculate reliability for it. Your assistance will help me to develop a quality instrument that can be used to capture the valuable data needed to
measure the teaching and learning with technology behaviors of agricultural educators.

To complete the survey instrument, please click on the link below. Your responses to the survey instrument will only be used to help me determine if it is producing similar results under consistent conditions and will not be included as part of my study data analysis, or shared with anyone else. It is my hope to conduct reliability tests early next week and to begin data collection by the end of the month.

**Follow this link to the Survey:**

[**Agricultural Educator Technology Behavior Survey**](https://pennstate.qualtrics.com/jfe/form/SV_cAzLWVqUWs6PX93)

Or copy and paste the URL below into your internet browser:

https://pennstate.qualtrics.com/jfe/form/SV_cAzLWVqUWs6PX93

Completion of the survey instrument should take no more than 10-15 minutes of your time, and can be done on the device of your choice.

The Institutional Review Board of The Pennsylvania State University approves this study for use of human subjects: PSU IRB # 13037. If you have any questions, please contact me.

Thank you for your assistance in my dissertation study instrument development process!

Yours Sincerely,

Tiffany Morey

Ph.D. Candidate in Agricultural and Extension Education  
Graduate Assistant for The Center for Professional Personnel Development  
The Pennsylvania State University  
012 Ferguson Building  
Department of Agricultural Economics, Sociology and Education  
University Park, PA 16802  
Email: tgm23@psu.edu
Study Recruitment Letter: Pre-Service Agriculture Teachers

Date: March 16, 2020

Dear [Name of Pre-Service Agriculture Teacher Candidate],

Now, more than ever, the technological demands of teachers (and teacher candidates) are moving at a rapid rate as we navigate the waters of virtual instruction. Because of this, I have chosen to study "Virtual Mentoring in Agricultural Education: Describing Digital Literacy, Technology Self-Efficacy, and Attitudes Towards Technology of Pre-Service and In-Service Agricultural Educators" for my dissertation study.

With rapid technological development, the need for in-service and pre-service teachers to have the knowledge, skills and strategies to integrate tools and platforms effectively is ever present. Digital literacy, technology self-efficacy, and attitude towards technology affect teachers’ ability to meaningfully transfer skills between personal to professional use, including purposeful integration into teaching and learning experiences, and influence how educators use technology, their comfort level with technology, and their willingness to use technology in teaching and learning practices. My research involves examining the digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication of pre-service agricultural teacher candidates and in-service agricultural educators who have and have not participated in a virtual mentoring program.

At Penn State, we work hard as a team to provide agricultural educators with high quality professional development materials and opportunities. It is my hope that the results of my dissertation study will help us develop resources and programming to assist agricultural educators at all stages of their career in developing best practices for teaching and learning with technology and for the delivery of effective virtual instruction to their students. It is my hope that by working with you and collecting your feedback, we can help can continue the Teach Ag Penn State legacy of excellence.

On March 18, 2020 you will receive an email containing a link to the survey instrument, which is being administered electronically via Qualtrics. The email will come from my Penn State email account (tgm23@psu.edu) with a subject line of Agricultural Educator Technology Behavior Survey. The link will be uniquely tied to the survey instrument and your email address. Qualtrics is a secure data collection platform, and all individual response data will be kept confidential. If the email does not show up in your inbox on March 18th, please check your spam folder, as certain email servers will automatically send emails from Qualtrics to that location.
I have attached a copy of the survey instrument to this email for you to review prior to the actual electronic administration.

The Institutional Review Board of The Pennsylvania State University approves this study for use of human subjects: PSU IRB # 13037. If you have any questions, please contact me. We truly appreciate your time and assistance in conducting research.

Yours Sincerely,

Tiffany Morey

Ph.D. Candidate in Agricultural and Extension Education
Graduate Assistant for The Center for Professional Personnel Development
The Pennsylvania State University
012 Ferguson Building
Department of Agricultural Economics, Sociology and Education
University Park, PA 16802
Email: tgm23@psu.edu
Phone: 609-204-0819
Date: March 27, 2020

Dear [Name of In-Service Agricultural Educator],

Now, more than ever, the technological demands of teachers are moving at a rapid rate as we navigate the waters of virtual instruction. Because of this, I have chosen to study "Virtual Mentoring in Agricultural Education: Describing Digital Literacy, Technology Self-Efficacy, and Attitudes Towards Technology of Pre-Service and In-Service Agricultural Educators" for my dissertation study.

With rapid technological development, the need for in-service and pre-service teachers to have the knowledge, skills and strategies to integrate tools and platforms effectively is ever present. Digital literacy, technology self-efficacy, and attitude towards technology affect teachers’ ability to meaningfully transfer skills between personal to professional use, including purposeful integration into teaching and learning experiences, and influence how educators use technology, their comfort level with technology, and their willingness to use technology in teaching and learning practices. My research involves examining the digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication of pre-service agricultural teacher candidates and in-service agricultural educators who have and have not participated in a virtual mentoring program.

At Penn State, we work hard as a team to provide agricultural educators with high quality professional development materials and opportunities. It is my hope that the results of my dissertation study will help us develop resources and programming to assist agricultural educators at all stages of their career in developing best practices for teaching and learning with technology and for the delivery of effective virtual instruction to their students. It is my hope that by working with you and collecting your feedback, we can help can continue the Teach Ag Penn State legacy of excellence.

On March 30, 2020 you will receive an email containing a link to the survey instrument, which is being administered electronically via Qualtrics. The email will come from my Penn State email account (tgm23@psu.edu) with a subject line of Agricultural Educator Technology Behavior Survey. The link will be uniquely tied to the survey instrument and your email address. Qualtrics is a secure data collection platform, and all individual response data will be kept confidential. If the email does not show up in your inbox on March 30, 2020, please check your spam folder, as certain email servers will automatically send emails from Qualtrics to that location.
I have attached a copy of the survey instrument to this email for you to review prior to the actual electronic administration.

The Institutional Review Board of The Pennsylvania State University approves this study for use of human subjects: PSU IRB # 13037. If you have any questions, please contact me. We truly appreciate your time and assistance in conducting research.

Yours Sincerely,

Tiffany Morey

Ph.D. Candidate in Agricultural and Extension Education
Graduate Assistant for The Center for Professional Personnel Development
The Pennsylvania State University
012 Ferguson Building
Department of Agricultural Economics, Sociology and Education
University Park, PA 16802
Email: tgm23@psu.edu
Phone: 609-204-0819
Study Instrument Administration E-Mail: Pre-Service Agriculture Teachers

Date: March 18, 2020

Dear [Name of Pre-Service Agriculture Teacher Candidate],

I hope you received my email and have reviewed the survey instrument! Now is the time to click on the link below, and spend 10-15 minutes completing this survey to help us help future ag teachers like you!

Follow this link to the Survey:
${l://SurveyLink?d=Take the Survey}

Or copy and paste the URL below into your internet browser:
${l://SurveyURL}

This link is uniquely tied to this survey and your email address. Please do not forward this message.

Please, complete this survey by April 1, 2020. The Institutional Review Board of The Pennsylvania State University approves this study for use of human subjects: PSU IRB # 13037.

If you have any questions, please contact me. We truly appreciate your time and assistance in the conduct of this research.

Thank you very much for completing this survey.

Yours Sincerely,

Tiffany Morey

Ph.D. Candidate in Agricultural and Extension Education
Graduate Assistant for The Center for Professional Personnel Development
The Pennsylvania State University
012 Ferguson Building
Department of Agricultural Economics, Sociology and Education
University Park, PA 16802
Email: tgm23@psu.edu
Phone: 609-204-0819
Date: March 30, 2020

Dear [Name of In-Service Agricultural Educator],

I hope you received my email and have reviewed the survey instrument! Now is the time to click on the link below, and spend 10-15 minutes completing this survey to help us help you and future ag teachers like you!

**Follow this link to the Survey:**
${l://SurveyLink?d=Take the Survey}$

Or copy and paste the URL below into your internet browser:
${l://SurveyURL}$

This link is uniquely tied to this survey and your email address. Please do not forward this message.

Please, complete this survey by April 13, 2020. The Institutional Review Board of The Pennsylvania State University approves this study for use of human subjects: PSU IRB # 13037.

If you have any questions, please contact me. We truly appreciate your time and assistance in the conduct of this research.

Thank you very much for completing this survey.

Yours Sincerely,

Tiffany Morey

Ph.D. Candidate in Agricultural and Extension Education
Graduate Assistant for The Center for Professional Personnel Development
The Pennsylvania State University
012 Ferguson Building
Department of Agricultural Economics, Sociology and Education
University Park, PA 16802
Email: tgm23@psu.edu
Phone: 609-204-0819
Study Instrument Completion Reminder E-Mail: Pre-Service Agriculture Teachers

Date: April 1, 2020

Dear [Name of Pre-Service Agriculture Teacher Candidate],

I know this can be a busy time of year as you prepare to wrap up the spring semester, but your feedback is really wanted! By spending 10-15 minutes right now, you can help us continue to coach up great future pre-service agriculture teachers like yourself by being a part of a study entitled “Virtual Mentoring in Agricultural Education: Describing Digital Literacy, Technology Self-Efficacy, and Attitudes Towards Technology of Pre-Service and In-Service Agricultural Educators”.

The original request was sent two weeks ago, and I still have not received your input!

On March 18, you received an email containing a link to the survey instrument, which is being administered electronically via Qualtrics. The email came from tgm23@psu.edu with a subject line of Pre-Service Agricultural Educator Technology Behavior Survey. The email contains a link that is uniquely tied to the survey instrument and your email address. If the email did not show up in your inbox on March 18, 2020, please check your spam folder, as certain email servers will automatically send emails from Qualtrics to that location. Qualtrics is a secure data collection platform, and all individual response data will be kept confidential.

Could you please take a few minutes from your busy schedule to complete the survey? Your responses are valuable to my efforts in examining the digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication of pre-service agricultural teacher candidates and in-service agricultural educators who have and have not participated in a virtual mentoring program.

Follow this link to the Survey:
${l://SurveyLink?d=Take the Survey}

Or copy and paste the URL below into your internet browser:
${l://SurveyURL}

This link is uniquely tied to this survey and your email address. Please do not forward this message.

Please, complete this survey by April 8, 2020 The Institutional Review Board of The Pennsylvania State University approves this study for use of human subjects: PSU IRB # 13037.

We truly appreciate your time and assistance in conducting this research.

Thank you again for your time and cooperation. If you have further questions, please contact me (tgm23@psu.edu or 609-204-0819). Best wishes.
Sincerely,

Tiffany Morey

Ph.D. Candidate in Agricultural and Extension Education
Graduate Assistant for The Center for Professional Personnel Development
The Pennsylvania State University
012 Ferguson Building
Department of Agricultural Economics, Sociology and Education
University Park, PA 16802
Email: tgm23@psu.edu
Phone: 609-204-0819
Date: April 13, 2020

Dear [Name of In-Service Agricultural Educator],

I know this is a busy and strange time with the closure of schools and transition to virtual instruction, but your feedback is really wanted! By spending 10-15 minutes right now, you can help us continue to coach up great future agriculture teachers by being a part of a study entitled “Virtual Mentoring in Agricultural Education: Describing Digital Literacy, Technology Self-Efficacy, and Attitudes Towards Technology of Pre-Service and In-Service Agricultural Educators”.

The original request was sent two weeks ago, and I still have not received your input!

On March 30, 2020 you received an email containing a link to the survey instrument, which is being administered electronically via Qualtrics. The email came from tgm23@psu.edu with a subject line of Agricultural Educator Technology Behavior Survey. The email contains a link that is uniquely tied to the survey instrument and your email address. If the email did not show up in your inbox on March 30, 2020, please check your spam folder, as certain email servers will automatically send emails from Qualtrics to that location. Qualtrics is a secure data collection platform, and all individual response data will be kept confidential.

Could you please take a few minutes from your busy schedule to complete the survey? Your responses are valuable to my efforts in examining the digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication of pre-service agricultural teacher candidates and in-service agricultural educators who have and have not participated in a virtual mentoring program. The Institutional Review Board of The Pennsylvania State University approves this study for use of human subjects: PSU IRB # 13037.

Follow this link to the Survey:
${l://SurveyLink?d=Take the Survey}

Or copy and paste the URL below into your internet browser:
${l://SurveyURL}

This link is uniquely tied to this survey and your email address. Please do not forward this message.

Please, complete this survey by April 20, 2020. The Institutional Review Board of The Pennsylvania State University approves this study for use of human subjects: PSU IRB # 13037.

We truly appreciate your time and assistance in conducting this research.

Thank you again for your time and cooperation. If you have further questions, please contact me (tg23@psu.edu or 609-204-0819). Best wishes.
Sincerely,

Tiffany Morey

Ph.D. Candidate in Agricultural and Extension Education
Graduate Assistant for The Center for Professional Personnel Development
The Pennsylvania State University
012 Ferguson Building
Department of Agricultural Economics, Sociology and Education
University Park, PA 16802
Email: tgm23@psu.edu
Phone: 609-204-0819
Date: April 9, 2020

Dear [Name of Pre-Service Agriculture Teacher Candidate],

I know this is a very busy time of year preparing for final projects and exams, but your feedback is really needed! By spending 10-15 minutes right now, you can help us continue to coach up great future pre-service agriculture teachers like yourself by being a part of a study entitled Virtual Mentoring in Agricultural Education: Describing Digital Literacy, Technology Self-Efficacy, and Attitudes Towards Technology of Pre-Service and In-Service Agricultural Educators”.

The original request was sent one month ago, and I still have not received your input!

Could you please take a few minutes from your busy schedule to the survey? I need to complete my Ph.D. dissertation and your responses are valuable to my efforts in examining the digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication of pre-service agricultural teacher candidates who have and have not participated in a virtual mentoring program.

Please complete the survey by April 24, 2020. Thank you again for your time and cooperation. If you have further questions, please contact me (tgm23@psu.edu or 609-204-0819). Best wishes.

Sincerely,

Tiffany Morey

Ph.D. Candidate in Agricultural and Extension Education
Graduate Assistant for The Center for Professional Personnel Development
The Pennsylvania State University
012 Ferguson Building
Department of Agricultural Economics, Sociology and Education
University Park, PA 16802
Email: tgm23@psu.edu
Phone: 609-204-0819
Date: April 21, 2020

Dear [Name of Agricultural Educator],

I know this is a busy time as you prepare for the end of the school year, but your feedback is really needed! By spending 10-15 minutes right now, you can help us continue to coach up great future agriculture teachers by being a part of a study entitled Virtual Mentoring in Agricultural Education: Describing Digital Literacy, Technology Self-Efficacy, and Attitudes Towards Technology of Pre-Service and In-Service Agricultural Educators".

The original request was sent one month ago, and I still have not received your input!

Could you please take a few minutes from your busy schedule to complete the survey? I need to complete my Ph.D. dissertation and your responses are valuable to my efforts in examining the digital literacy behaviors, digital technology self-efficacy levels, and attitudes towards digital communication of pre-service agricultural teacher candidates who have and have not participated in a virtual mentoring program.

Please complete the survey by April 30, 2020. Thank you again for your time and cooperation. If you have further questions, please contact me (tgm23@psu.edu or 609-204-0819). Best wishes.

Sincerely,

Tiffany Morey

Ph.D. Candidate in Agricultural and Extension Education
Graduate Assistant for The Center for Professional Personnel Development
The Pennsylvania State University
012 Ferguson Building
Department of Agricultural Economics, Sociology and Education
University Park, PA 16802
Email: tgm23@psu.edu
Phone: 609-204-0819
APPENDIX C: SURVEY INSTRUMENT
Digital Behavior and Characteristics Data Collection Instrument
Welcome to the Research Study!

We are interested in understanding the digital literacy behaviors, technology self-efficacy levels, and attitudes towards technology of in-service and pre-service agriculture teachers. You will be presented with information relevant to your digital literacy behaviors, technology self-efficacy, and attitude towards technology and asked to answer questions about it. Please be assured that your responses will be kept completely confidential.

The study should take approximately 15 minutes to complete. Your participation in this research is voluntary. You have the right to withdraw at any point during the study, for any reason, and without any prejudice. If you would like to contact the Principal Investigator in the study to discuss this research, please e-mail Tiffany Morey at tgm23@psu.edu.

By clicking the button below, you acknowledge that your participation in the study is voluntary, you are 18 years of age, and that you are aware that you may choose to terminate your participation in the study at any time and for any reason.

Please note that this survey will be best displayed on a laptop or desktop computer. Some features may be less compatible for use on a mobile device.

  a.  I consent, begin the study (proceed to survey questions)
  b.  I do not consent, I do not wish to participate (proceed to end of survey)

Participant Information
1.  What is your affiliation with agricultural education?
   a.  In-Service Agriculture Teacher
   b.  Pre-Service Agriculture Teacher

2.  Have you participated in The Pennsylvania State University Pre-Service Agriculture Teacher Virtual Mentoring Program?
   a.  Yes
   b.  No

3.  If yes, what was your participation role in The Pennsylvania State University Pre-Service Agriculture Teacher Virtual Mentoring Program? (Please select all that apply).
   a.  Mentee
   b.  Recent Program Graduate Mentor
   c.  In-State Agriculture Teacher Mentor
   d.  Out-of-State Agriculture Teacher Mentor
   e.  Cooperating Teacher
**Digital Literacy Information**

The purpose of this section is to gather information about digital literacy behaviors. Digital literacy is having the technical ability to use technology to improve teaching through the use of multiple platforms and tools for instruction and professional communication. For each item, please choose the one response (Strongly Agree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree) that best describes you. Please answer all of the questions and if you are uncertain or neutral about your response, you may select "Neither Agree nor Disagree".

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I know how to solve my own technical problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. I can learn new technologies easily.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I keep up with important new technologies.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. I know about a lot of different technologies.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I have the technical skills I need to use technology for learning and to create digital artifacts (e.g. presentations, digital stories, wikis, blogs) that demonstrate my understanding of what I have learned.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. I have good technology skills.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. I am confident with my search and evaluate skills in regards to obtaining information from the Web.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I am familiar with issues related to web-based activities e.g. cyber safety, search issues, plagiarism.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Technology enables me to collaborate better with my peers on project work and other learning activities.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. I frequently obtain help with my work from my friends over the Internet e.g. through Skype, Facebook, Blogs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Technology Self-Efficacy Information
The purpose of this section is to gather information about technology self-efficacy. Digital technology self-efficacy is the self-assessment of one’s capabilities to use certain forms of digital communication technology. For each item, please choose the one response (Strongly Agree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree) that best describes you. Please answer all of the questions and if you are uncertain or neutral about your response, you may select "Neither Agree nor Disagree".

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I can update an instructional material (paper based, electronic or multimedia materials, etc.) based on the needs (students, environment, duration, etc.) by using technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. I can use technology to determine students’ needs related to a content area in the pre-teaching process.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I can use technology to develop activities based on student needs to enrich the teaching and learning process.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. I can plan the teaching and learning process according to available technological resources.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I can conduct a needs analysis for technologies to be used in the teaching and learning process to increase the quality of teaching.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. I can optimize the duration of the lesson by using technologies (education software, virtual labs, etc.).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. I can develop appropriate assessment tools by using technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I can combine appropriate methods, techniques, and technologies by evaluating their attributes in order to present the content effectively.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. I can use technology to appropriately design materials to the needs for an effective teaching and learning process.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statement</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>-------------------</td>
<td>----------</td>
<td>----------------------------</td>
<td>-------</td>
<td>----------------</td>
</tr>
<tr>
<td>10. I can organize the educational environment in an appropriate way to use technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. I can implement effective classroom management in the teaching and learning process in which technology is used.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. I can assess whether students have the appropriate content knowledge by using technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. I can apply instructional approaches and methods appropriate to individual differences with the help of technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. I can use technology for implementing educational activities such as homework, projects, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. I can use technology-based communication tools (blog, forum, chat, e-mail, etc.) in the teaching process.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. I can use technology for evaluation students’ achievement in related content areas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. I can be an appropriate model for the students in following codes of ethics for the use of technology in my teaching.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. I can guide students in the process of designing technology-based products (presentations, games, films, etc.).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. I can use innovative technologies (Facebook, blogs, Twitter, podcasting, etc.) to support the teaching and learning process.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. I can use technology to update my knowledge and skills in the area that I will teach.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. I can update my technological knowledge for the teaching process.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. I can use technology to keep my content knowledge updated.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. I can provide each student equal access to technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statement</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>-------------------</td>
<td>----------</td>
<td>----------------------------</td>
<td>-------</td>
<td>----------------</td>
</tr>
<tr>
<td>24. I can behave ethically in acquiring and using special/private information which will be used in teaching a subject area via technology (audio records, video records, documents, etc.).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. I can use technology in every phase of the teaching and learning process by considering copyright issues (e.g. license).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. I can follow the teaching profession’s code of ethics in online educational environments (WebCT, Moodle, etc.).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. I can provide guidance to students by leading them to valid and reliable digital sources.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. I can behave ethically regarding the appropriate use of technology in educational environments.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. I can troubleshoot problems that could be encountered with online educational environments (WebCT, Moodle, etc.).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. I can troubleshoot any kind of problem that may occur while using technology in any phase of the teaching-learning process.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31. I can use technology to find solutions to problems (structuring, updating relating the content to real life, etc.).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32. I can become a leader in spreading the use of technological innovations in my teaching community.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33. I can cooperate with other disciplines regarding the use of technology to solve problems encountered in the process of presenting content.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Attitudes Toward Technology Information
The purpose of this section is to gather information about attitude toward technology. Attitude toward digital technology are the beliefs held and experiences had by individuals that contribute to their use of technology. For each item, please choose the one response (Strongly Agree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree) that best describes you. Please answer all of the questions and if you are uncertain or neutral about your response, you may select "Neither Agree nor Disagree".

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I believe that technology improves the efficiency of work.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. I like to use technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I closely follow the work on technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. I'm interested in technology research.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I believe in the necessity of technology for a better quality of life.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Learning technology is fun.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. I encourage people to use technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I like to learn about technological developments.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Learning the technological developments is an extra burden for me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. I like to buy books and magazines about technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. I'd like to have a job in technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. I'm tired of reading about new developments in technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. I'm interested in learning interesting information about technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. I like technology to be useful to me in daily life.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Every citizen should understand technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. I spend my free time learning more about technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. I inform those in my surroundings about the use of technology in everyday life.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Technology Usage Information

1. Do you have a Twitter account?
   a. Yes
   b. No

2. If yes, how many Tweets do you author per month?

3. Do you participate in online blogging?
   a. Yes
   b. No

4. If yes, how do you participate in online blogging?
   a. Author Blog Posts
   b. Leave Feedback/Comments on Blog Posts
   c. Both

5. Approximately how many blog posts do you author per month?

6. Do you participate in video observation of teaching and learning?
   a. Yes
   b. No

7. If yes, how do you participate in video observation of teaching and learning?
   a. Record and Upload Videos
   b. Leave Feedback on Videos
   c. Both

8. How many videos of teaching and learning do you record per month for observation?
VITA

Tiffany G. Morey

EDUCATION

The Pennsylvania State University, University Park, PA
Ph.D., Agricultural and Extension Education
Minor: Learning Design Technology
Graduated: August 2020

Rutgers University Graduate School of Education, New Brunswick, NJ
M. Ed., Agricultural Science Education
Graduated: May 2010

Cook College, Rutgers- The State University of New Jersey, New Brunswick, NJ
B.S., Animal Science-Pre-Veterinary Medicine
Minors: Equine Science, Biology, Science Teacher Education
Graduated: May 2009, Cum Laude

RELEVANT EXPERIENCE

The Pennsylvania State University, University Park, Pennsylvania
Graduate Assistant, August 2017 to present
• Digital coach for pre-service agriculture teacher student cohorts
• Monitor and oversee virtual mentoring program for student teachers
• Create and maintain Canvas course learning spaces
• University supervisor of student teachers
• Assist The Center for Professional Personnel Development with program planning, development, and implementation
• Co-author on winning College of Agricultural Sciences Student Technology Fee Grant to obtain supportive equipment for student teacher video observations

ACTIVITIES AND AWARDS

• Member, American Association for Agricultural Education (AAAE), 2018-present
• Member, North American Colleges and Teachers of Agriculture (NACTA), 2018-present
• Member, Penn State Agricultural and Extension Education Graduate Student Association, 2017-present
• Member, Gamma Sigma Delta, 2019-present
• Recipient, NACTA Graduate Student Teaching Award, 2020