Virtual Mentoring in Agricultural Education: Describing Digital Literacy, Technology Self-Efficacy, and Attitudes Toward Technology of Secondary Agricultural Educators

Abstract

Digital literacy, technology self-efficacy, and attitude toward technology play an impactful role in the life of 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. This study examined the effects of participation in a virtual mentoring program on the digital literacy, technology self-efficacy, and attitude toward technology of secondary agriculture teachers. We found secondary agriculture teachers who had participated in a virtual mentoring program exhibited higher overall digital literacy levels and technology self-efficacy levels than those secondary agriculture teachers who had not participated in a virtual mentoring program. Pragmatic implications include a defined opportunity for agricultural education leaders to develop appropriate and beneficial tools and materials to assist in-service agriculture teachers in developing digital literacy skills, technology self-efficacy skills, and a positive attitude toward technology. Recommendations for future research include examining different means of establishing virtual mentoring relationships between secondary agriculture teachers and exploring virtual professional development opportunities designed to help educators develop digital literacy, technology self-efficacy, and a positive attitude toward technology.

Keywords: Teacher Education; Mentoring; Digital Literacy; Technology Self-Efficacy

Introduction and Theoretical Background

"Rapidly evolving technology has not only fundamentally changed the way in which we live, work and communicate, but also revolutionized the education system" (Li et al., 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 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; Williams et al., 2014). 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; the change of practice can be incremental as 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).

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 has knowledge of different technological tools and how to model their utilization; while also being able to teach their students about the technologies and their uses (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).

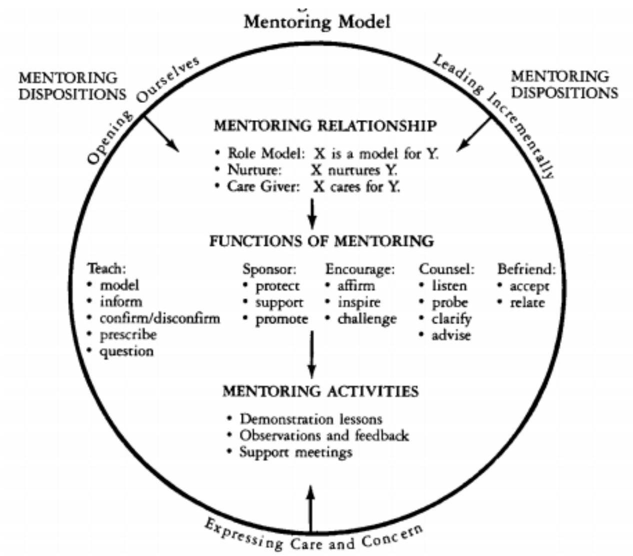
Technology self-efficacy is the self-assessment of one's capabilities to use certain forms of digital communication technology and has been identified as an important variable that is related to their use of technology (Pynoo et al., 2011; Teo, 2011). Technology self-efficacy can be a key determinant of both initial technology usage and long-term usage intentions and behaviors (Sun, 2008); while being consistently and strongly related to their usage of technology in their teaching and learning practices (Kao et al., 2014). Teachers with higher technology-related self-efficacy have increased inclinations to use technology in their teaching and learning practices (Paraskeva, et al., 2008). Teachers prefer to develop digital literacy and technology self-efficacy through collaboration with other teachers who are already using and integrating technology successfully, (Hatlevik & Hatlevik, 2018; Smith et al., 2018). Teachers' technology self-efficacy is not a constant, but it is affected by factors such as mastery experiences, vicarious experiencessuch as mentoring, and feedback from others who have a significant impact on their teaching practices (Elstad & Christophersen, 2017, Hatlevik & Hatlevik, 2018).

Attitude toward technology is the beliefs held and experiences had by individuals that contribute to their use of technology. Attitude toward technology 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 individual 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). Reid (2017) identified the variables of the technology itself, the process of using it, how it is administered, the environment in which it is implemented, and the faculty dynamics as major factors into whether a teacher will choose to adopt technology in their classrooms. Ata & Yıldırım (2019) confirmed and further described Reid's findings by noting 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.

When teachers have high levels of digital literacy and technology self-efficacy, and a positive attitude toward technology, they may find it easier to use technology in their teaching and learning practices (Joo et al., 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. 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). 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 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. Anderson and Shannon (1988) found that successful mentoring relationships are built around the tenets of role modeling, nurturing, and caring, with mentors and mentees engaging in experiences that promote teaching, sponsorship, encouragement, counseling, and friendship as depicted in *Figure 1: Anderson and Shannon's (1988) Mentoring Cycle*.

Figure 1

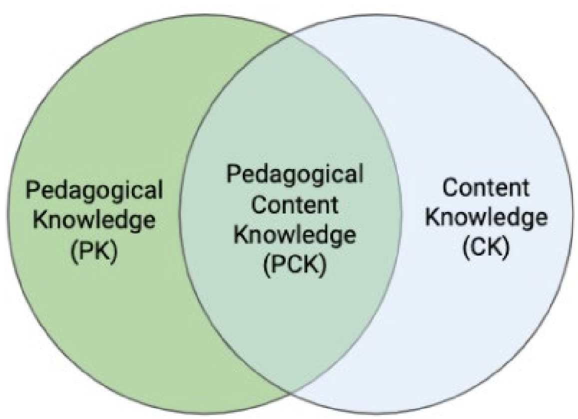
Anderson and Shannon's (1988) Mentoring Cycle



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). Mentoring relationships serve as spaces for educators to engage in discourse and resource sharing around pedagogy content knowledge (PCK). Shulman (1987, 1986) was the first to create a visual model of PCK (see *Figure 2: Pedagogy Content Knowledge (PCK) Model*) where PK stands for pedagogical knowledge, CK stands for content knowledge, and PCK represents the intersection of the two. As the usage of educational technology has increased, how educators engage in PCK has changed.

Figure 2

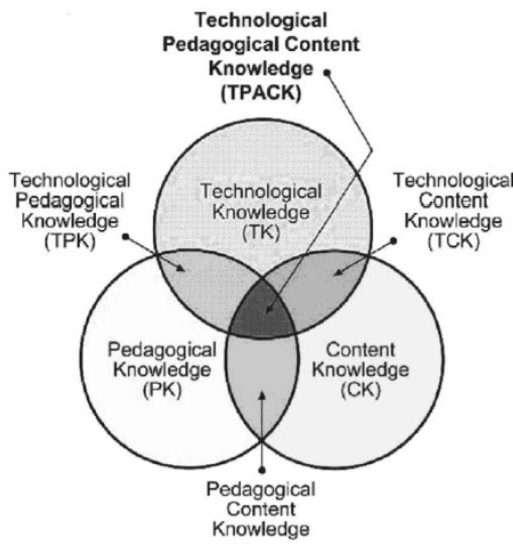
Pedagogy Content Knowledge (PCK) Model (Shulman, 1986, 1987)



Koelher and Mishra, (2009) created a framework depicting how technological, pedagogical, and content knowledge (TPACK) work together to allow educators to integrate the use of technology into PCK. 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 can help teachers improve student learning (Thompson & Misra, 2007). TPACK can be used to how teachers' understanding of educational technologies and PCK interact with one another to produce effective teaching with technology. The TPACK model illustrated in *Figure 3: Technological, Pedagogical and Content Knowledge (TPACK) Model* shows the complex interactions between content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK).

Figure 3

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



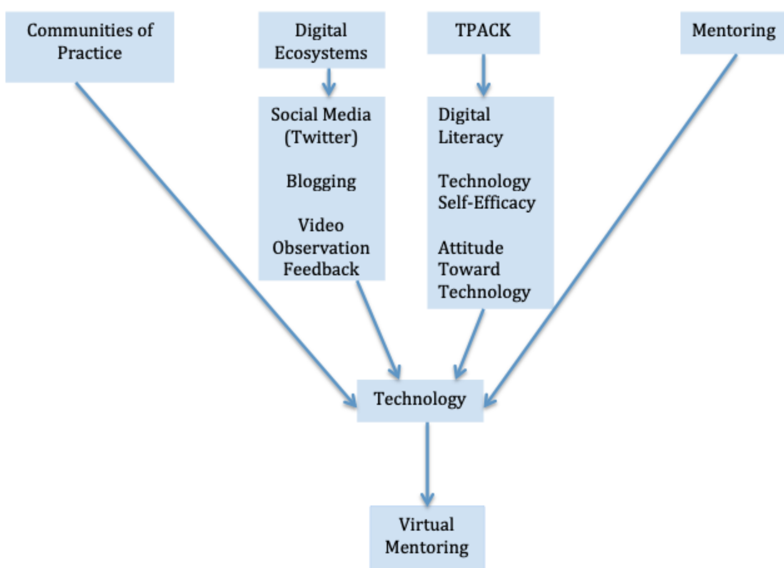
When technology is added to a community of practice, it can result in the creation of online professional learning communities (Liu, 2012). Because online professional learning communities require the use of technology, they allow for the creation of spaces where technological pedagogical content knowledge (TPACK) can be discussed and best practices for teaching and learning with technology can be shared (Koehler & Mishra, 2009). Within online professional learning communities, digital ecosystems can arise. 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 the adaptive and sustainable processes from natural ecosystems (Briscoe, Sadedin, & De Wilde, 2011). Digital ecosystems can include platforms related to digital communication, reflection, and observation. Through participation in online 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).

Online professional learning communities can be used as a forum for mentoring relationships between teachers. With the guidance of virtual mentors in an online professional learning community, teachers can appropriately prioritize attention to technology aspects of teaching and learning (Liu, 2012). 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, and offer practical assistance, as well as reflect, think, and process about teaching and learning practices. Additional benefits of virtual mentoring include sharing, giving, and receiving feedback; decreased feelings of isolation; increased feelings of resilience; and the development of greater technology self-efficacy (Owen, 2015).

The conceptual model that guided the study is presented in *Figure 4: Conceptual Model for Virtual Mentoring Impact on TPACK Behaviors.* Based on the importance of the development of *digital literacy*, *technology self-efficacy,* and *attitude toward technology,* The Pennsylvania State University developed a formal virtual mentoring program to create digital support teams for pre-service agricultural educators in the 2017-2018 academic year. This program served as the foundation for the study. The virtual mentoring program occurred when several key elements of the teaching and learning process: communities of practice, mentoring, and pedagogy content knowledge, were combined with technology. 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. 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).

Figure 4

Conceptual Model for Virtual Mentoring Impact on TPACK Behaviors



The virtual mentoring program allowed mentors and mentees to participate in an online professional learning community on a regular basis and to experience participation in a digital ecosystem that utilized Twitter, Blogger, and Edthena, a video observation platform supporting the finding that 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). Prior researchers (Ebner et al., 2010; Reese, 2016; Williams & Jacobs, 2004) reported that using digital communication platforms could help teachers become more tech savvy and that participation in virtual mentoring using one specific means or channel could be beneficial (Owen, 2015). Based on the recommendations of Coley et al. (2015), virtual mentors chosen for the virtual mentoring program exhibited high levels of digital literacy and technology self-efficacy, along with a positive attitude toward technology. The mentors sought to help their mentees improve their own digital literacy, technology self-efficacy, and attitude by engaging in shared digital tasks and experiences. Having positive experiences using technology for teaching and learning in a space where there is the opportunity to develop active teaching strategies can lead to a positive attitude toward technology (Ata & Yıldırım, 2019). Participation in an online professional community that utilizes the sharing ideas for how technology can be used in the teaching and learning process can also help expand teachers' digital literacy (Koltay et al., 2015).

The effects of a combination of platforms to form a digital ecosystem and their impact on *digital literacy*, *technology self-efficacy*, and *attitude toward technology* of secondary teachers are not readily found in the literature. Research is 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*, which have been identified as important traits for new and experienced teachers to develop and exhibit (Nascimento & Knobel, 2017). This study sought to explore these gaps of knowledge and supported research priority areas 2 (New Technologies, Practices and Product Adoption Decision) and research priority area 3 (Sufficient Scientific and Professional Workforce that Address the Challenges of the 21st Century) found in the national research agenda of the American Association for Agricultural Education (Roberts et al., 2016).

Purpose and Objectives

The purpose of the study was to describe the impact of virtual mentoring program participation on *digital literacy* behaviors, *technology self-efficacy* levels, and *attitudes towards technology* of secondary agricultural educators. The following research objectives guided the study:

1. Describe the digital literacy of secondary agriculture teachers from different states who have and have not participated in a virtual mentoring program using Ng's (2012) Digital Literacy Skills instrument.
2. Describe the digital technology self-efficacy of secondary 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.
3. Describe the attitudes towards digital communication of secondary 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.

Methods

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 secondary agricultural educators. The study was conducted in March and April of 2020, just as the COVID-19 pandemic began. Participants in the study were secondary agriculture teachers representing two distinct groups: teachers who had participated in the virtual mentoring program and teachers who had not participated in the virtual mentoring program at The Pennsylvania State University. The group representing secondary agriculture teachers who had participated in the virtual mentoring program comprised four types of individuals: recent program graduates from The Pennsylvania State University, agriculture teachers from Pennsylvania, cooperating teachers from 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 76 individuals from this group were surveyed.

The secondary agriculture teachers representing the group that had not participated in the virtual mentoring program comprised agriculture teachers who had no prior affiliation or experience with the virtual mentoring program but were from the same state that housed the agricultural teacher education program conducting 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. There were 80 teachers randomly selected as part of that group. None of the teachers selected were compensated for their time or study participation.

The survey instrument was designed to capture information on digital literacy technology self-efficacy, and attitudes towards technology utilizing a combination of questions taken from three existing instruments. Each instrument independently measured either digital literacy, technology self-efficacy, or attitudes towards technology. The questions related to digital literacy were taken from the Digital Literacy Skills scale developed by Ng (2012). Ng's (2012) instrument consisted of 10 items. 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 and consisted of 33 items. The questions related to attitudes towards technology were taken from an instrument that measures teachers' attitudes toward technology that was developed by Aydın and Karaa (2013) and contained 17 items. The original instrument questions were not adapted on any of three and all three evaluated responses from a 5-point Likert-type scale, with response choices of: *strongly disagree, disagree, neither agree or disagree, agree, and strongly agree*.

The three instruments had primarily been used with pre-service teacher candidate audiences; therefore, the reliability of the survey instrument for a similar but different audience of secondary agriculture teacher population was verified through the utilization of a pilot test. The pilot test included 38 current secondary agriculture teachers who were not part of the study population, were from a state other than Pennsylvania and that had not participated in the virtual mentoring program. Reliability tests were conducted using a Cronbach's Alpha test for internal consistency. 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 because of this test, which preserved content validity. The reliability statistics for secondary teachers are shown in Table 1.

Table 1

Reliability of Survey Instrument Components Pilot with Secondary Teachers (N=36)

Survey Instrument Component	*Cronbach Alpha Reliability Coefficient*
Digital Literacy Skills Scale (Ng, 2012)	0.818
TPACK Deep Scale (Technology Self-Efficacy) (Kabakci-Yurdakul et al., 2012)	0.957
Attitude Toward Technology (Aydin & Karaa, 2013)	0.816

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)

Face validity was established by having a secondary agriculture teacher that had not participated in the virtual mentoring program review the study instrument in a cognitive interview conducted through a video conference platform. While completing the survey instrument, the subject provided feedback about the format and appearance of the instrument. 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 was addressed by using a panel of experts to evaluate the study instrument. The panel of experts for this study consisted of researchers from The Pennsylvania State University who work in teacher education.

The protocol for the collection was developed using *Dillman's Internet, Phone, Mail, and Mixed-Mode Surveys, The Tailored Design Method, 4th ed.* (2014) and is presented in Table 2. The instrument was administered to participants through Qualtrics. The survey was sent to potential respondents via e-mail. Secondary agriculture teachers who participated in the virtual mentoring program were contacted using email addresses they provided for virtual mentoring program communication. Secondary agriculture teachers who have not participated in the virtual mentoring program were contacted using school district email addresses listed in the Pennsylvania Agriculture Teacher Directory database.

Table 2

Survey Instrument Administration Timeline

Time Point	Action	Item
2 Days Pre- Electronic Survey Administration	Email	Study informational letter, copy of survey instrument
Electronic Survey Administration	Email	Link to electronic survey instrument
2 Weeks Post- Electronic Survey Administration	Email	Survey reminder
1 Month Post- Electronic Survey Administration	Email	Survey Reminder

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 secondary agriculture teachers. 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 secondary 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 secondary agriculture teachers ($t(86) = .337$, $p = .737$). For the study, a completed response is considered one that has 85% of the survey items answered (Brosnan et al., 2017). Only completed survey responses were included for data analysis. A summary of total and complete survey responses is shown in Table 3.

Table 3

Summary of Survey Response Rates

Item		*n*	*%*
Overall Surveys Received	Secondary Agriculture Teachers (155 Surveyed)	100	64.5
Usable Surveys Received	Secondary Agriculture Teachers (155 Surveyed)	90	58.1
Response Rate	Secondary Agriculture Teachers (155 Surveyed)	90	58.1

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). 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 had and had not participated in the virtual mentoring program. 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 can be an inaccurate representation of the sample it represents (Dorofeev & Grant, 2006). Because the population of secondary agriculture teachers who had participated in the virtual mentoring program was 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).

Since 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, and 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.

There are limitations to the study that should be noted. As with many studies, the size of the population provides certain statistical limitations. In addition, during this study in the middle of data collection a global pandemic occurred where educators in the population could have been moved to virtual settings for instruction, potentially influencing their perceptions and confidence about technology in their instruction. This resulted in agriculture teachers from every state having to cease face-to-face instruction and switch to remote instruction with little to no warning (Lindner et al., 2020).

Results

Of the secondary agriculture teacher study respondents, the majority 62.2% (n=56) had participated in the virtual mentoring program and the majority 64.4% (n=58) were regular Twitter users, while the minority 11.1% (n=10) regularly participated in blogging. The percentage of 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 secondary agriculture teacher participants is shown in Table 4.

Descriptive statistics were run for each digital literacy, technology self-efficacy, and attitude toward technology survey item and overall digital literacy, technology self-efficacy, and attitude score for all secondary agriculture teacher survey respondents. Overall digital literacy, technology self-efficacy, and attitude toward scores for secondary agriculture teachers who have and have not participated in the virtual mentoring program are shown in Table 5. For overall digital literacy score mean values, overall technology self-efficacy score mean values, and overall attitude toward technology score mean values of secondary teachers who had participated in the virtual mentoring program and of secondary teachers who had not participated in the virtual mentoring program, skewness and kurtosis values were within the acceptable ranges and analysis of the histograms and normal Q-Q plots supported the normality assumption.

Table 4

Summary of Demographic Variables: Secondary Teachers

Item		*n*	*%*
Virtual Mentoring Program Participation	Yes	56	62.2
	No	34	37.8
Twitter User	Yes	58	64.4
	No	31	34.4
Blogging Participant	Yes	10	11.1
	No	79	88.8
Video Observation Participation	Yes	49	54.4
	No	39	43.3

Note. Some numbers in this table do not add to the total number of respondents due to individuals not answering survey instrument items.

An independent sample *t*-test was run for overall digital literacy score of secondary 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 secondary 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 secondary 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).

Table 5

Secondary Agriculture Teacher Overall Technology Behavior Scores

Item	*Virtual Mentoring Program Participants*		*Non-Participants*	
	M	*SD*	*M*	*SD*
Overall Digital Literacy Score (Total Possible Score=50)	38.9	5.6	35.71	6.2
Overall Mean Technology Self-Efficacy Score (Total Possible Score=165)	130.3	17.1	122.7	17.7
Overall Mean Attitude Toward Technology Score (Total Possible Score=85)	55.6	7.6	56.3	1.6

Note. 1=Strongly Disagree, 2=Disagree, 3=Neither Agree nor Disagree, 4-Agree, 5=Strongly Agree

An independent sample *t*-test was run for overall technology self-efficacy score of secondary agriculture teachers who had and had not participated in the virtual mentoring program. 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 secondary 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 secondary 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).

An independent sample *t*-test was run for overall attitude toward technology score of secondary 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 secondary agriculture teachers.

Conclusions and Recommendations

Secondary agriculture teachers who had participated in the virtual mentoring program exhibited statistically significantly higher overall digital literacy levels than secondary agriculture teachers who had not participated in the virtual mentoring program. Secondary 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 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. In the virtual mentoring program, secondary agriculture teachers regularly communicated and collaborated with their pre-service agriculture teacher mentee and the other secondary agriculture teachers who were also part of the mentee's mentoring team.

Interestingly, although the difference was not statistically significant, secondary agriculture teachers who participated in the virtual mentoring program had slightly lower overall attitude toward technology scores than secondary agriculture teachers who did not participate in the virtual mentoring program. We would supposition that those who used technology more were more aware of the capacity of the technology, and thus, disappointment in their ability to maximize that capacity as well a more frequent use would present increased opportunities for technological frustration. 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 supported 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. It should be noted that the study was conducted at the beginning of the COVID-19 pandemic when many agricultural educators had to switch to virtual learning without warning. As such, this may have affected the attitude toward technology responses of study respondents.

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.

As we look for pragmatic application of the findings of the study around the development of digital literacy skills, technology self-efficacy skills, and positive attitude toward technology for secondary teacher there several research and programmatic recommendations. As a profession, it would be advantageous to explore how virtual mentoring relationships could be established between secondary agriculture teachers with advanced digital literacy, technology self-efficacy, and attitude toward skill sets and those secondary agriculture teachers who wish to improve their proficiency in those areas. A first step in this process could be the development of an online community of practice with a focused digital ecosystem or the expansion and investment into existing online community like the NAAE Community of Practice with a focus on systematically connecting providers of professional development for secondary agricultural educators at the state and local district level with one another and with the teachers they serve. Connection to content providers (example; LinkedIn Learning) who target digital fluency skills could help advance the digital skills of our secondary educators, which have been evidenced as increasingly vital due to multiple factors. To support continued investment in this intentional professional development and to address the limitations of this study with population size, participation could include planned pre- and post-evaluation and data collection of participants. This would call for coordination between professional organizations, state departments of education, and researchers in agricultural education.

The COVID-19 pandemic caused one of the most significant disruptions in the history of education and has resulted in many agricultural educators teaching virtually for over a year (Daniel, 2020). While research has been done to examine how the pandemic has affected the work-life balance and job satisfaction of agricultural educators, no research currently exists on how it has affected their teaching behaviors (McKim & Sorenson, 2020). It would be advantageous to examine how this has affected their perceived levels of digital literacy, technology self-efficacy, and attitude toward technology, and what tools they identify to help them develop these skills.

Further, we should intentionally seek to cultivate and develop diverse mentoring relationships between our U.S. secondary agricultural educators as we continue to work to benefit from the advantages of a strong community of practice (Wenger, 2007). It is recommended that virtual mentoring relationships are established between secondary teachers with high levels of digital literacy and technology self-efficacy and a positive attitude toward technology and secondary teachers that wish to develop these behaviors. Of particular benefit could be the hybrid vigor developed through the connection of educators from different regions of the country that would not normally have reason to interact. In doing this, the profession could utilize collaboration between state and national agriculture teacher professional organizations to develop a process to identify and recruit agriculture teachers interested in participating in a virtual mentoring program as mentors and mentees.

As we view ensuring a well-prepared, sufficient workforce in agricultural education prepared to engage appropriately with the challenges of our day, further research is recommended along all points of the teacher education, teacher identity continuum including pre-service candidates on what interventions yield the highest return on investment regarding *digital literacy, technology self-efficacy, and attitude toward technology.*

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