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Openness and Preparedness of Senior FFA Members Toward Technology in Agriculture

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Abstract

School-Based Agricultural Education provides students the opportunity to engage with new and emerging agricultural technologies. Employers value employability skills such as openness, preparedness, and adaptability. However, the Agricultural Education literature is limited on the preparation of students in these skills. We conducted a descriptive study to explore how open and prepared 2020-2021 high school senior members of the National FFA Organization were for 10 selected new and emerging Agriculture, Food, and Natural Resources (AFNR) technologies. Additionally, the study evaluated the methods through which members learned about technology. An overview of students' contact with the 10 selected technologies and their experiences using these technologies contributes to an understanding of methods used in the classroom and how adaptable students may be for emerging technologies in the future. The study occurred in fall 2020 with 1,528 respondents completing the online survey. Almost all respondents reported personal access to a smart phone and computer at home with internet access. Respondents reported use or contact with the 10 selected technologies with that contact most often being in the agriculture classroom/laboratory. Respondents reported self-perceived very strong adaptability, high openness, and average preparedness. This could imply study respondents are open to new and emerging AFNR technologies but not prepared.

Keywords: new and emerging technologies; openness; preparedness; adaptability; National FFA Organization; AFNR career pathways

Author Note: This work is a result of a research collaboration with staff members at the National FFA Organization. Beyond helping set the scope of the research project National FFA Organization Staff did not conduct research procedures.
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Introduction

After World War II, farming practices were intensified to feed the developing world (van Mourik et al., 2021). Over the decades since, innovations in agricultural technology have helped maximize efficiency, provide a safer food supply, and create a more positive impact on the environment (United States Department of Agriculture, n.d.). The BIS Research blog on smart farming (2018) highlighted agriculture technology is increasing in use and impact with its market value reaching $23.14 billion by 2022. The industry of agriculture will need the aid of automation and robotics to feed a population that is expected to reach nine billion people over the next 30 years (Koostra et al., 2021). The role of precision technology in agriculture will be increasingly important in the coming generation of agriculture (van Mourik et al., 2021).

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To fill new jobs and keep pace with technological innovations, there must also be adaptations in classroom learning (Lorenzo, 2016). Daggett (2010) stated "students of the 21st century need a technology-based education to survive in a technological world" (p. 1). He also noted while schools have improved their methods of education, improvements must continue to stay relevant for the rapidly changing workforce.

School-Based Agricultural Education has introduced students to agricultural technologies including in recent decades microcomputers in the 1980s (Becker & Shoup, 1985; Church & Foster, 1984; Miller & Kotrlik, 1987; Rohrbach & Stewart, 1986) and biotechnology in the 1990s and early 2000s (Boone et al., 2006; Dormody, 1993; Wilson et al., 2002; Wingenbach et al., 2003). Entering the 2020s, agriculture teachers are utilizing smartphones and apps as learning tools in the classroom (Coley et al., 2015; Smith, Blackburn, et al., 2018; Smith, Stair, et al., 2018; Smith et al., 2019).

This study sought to identify how open and prepared members of the National FFA Organization (FFA) are for 10 selected new and emerging Agriculture, Food, and Natural Resources (AFNR) technologies. Additionally, the study evaluated the methods through which members learn about technology. An overview of students' contact with the 10 selected technologies and their experiences contributes to an understanding of methods used in the classroom and how adaptable students may be for emerging technologies in the future.

Literature Review

Throughout history, technology has played an integral role in agriculture. Innovations to machinery, seeds, and chemicals have paved the way for higher production yields and less waste (Fitzgerald, 1991). Adhikari et al. (2009) studied Young and Beginning Farmers and Ranchers (YBFR), which is a group close in age range to this study of high school seniors. Adhikari et al. found YBFR were eager to maximize efficiency and increase profitability in their operations, so they could not afford to waste time or resources on older technologies. Focus groups conducted at the 2012 Young Ag Leaders Conference (YALC) in Montana by Bailey et al. (2014) showed a majority of YBFRs desired unbiased education about new and emerging technologies to ensure they are staying relevant and not simply chasing new trends.

In the last 25 years, there have been several studies conducted about technology integration by agriculture teachers in their classrooms (Brickner, 1995; Christensen et al., 2009; Coley et al., 2015; Ertmer, 2005; King et al., 2019; Kotrlik & Redmann, 2009; Kotrlik et al., 2003; Lorenzo, 2012). It is important for students to receive a relevant education that allows them to understand and use the innovations and resources prevalent in business and industry. In their 2003 study about technology integration, Kotrlik et al. reviewed the levels of use and comfortability with technology for agriscience teachers in Louisiana. Their study was one of the first to show the relationship between teacher anxiety toward technology and classroom integration. At the time, technology integration was still relatively new in teaching experiences, and those who were anxious about using technology did not effectively integrate it in their classrooms. The authors emphasized the need of all stakeholders to buy in to this paradigm change to positively affect teaching and learning experiences.

In a later study, Kotrlik and Redmann (2009) found teachers who were less anxious about, and more familiar with, technology identified new ways to integrate it into their classrooms. Nevertheless, the teachers in their study had yet to maximize the use of technology in their instruction. Christensen et al. (2009) urged for training to be provided for in-service Career and Technical Education (CTE) teachers in the area of emerging agricultural technologies and their related careers. Other studies have identified additional barriers to technology integration. Coley et al. (2015) evaluated teachers' use of technology and found teachers are slow to adopt technologies in their classrooms. This can be explained by pedagogical beliefs, attitudes toward change, or lack of equipment or technical support (Brickner, 1995; Ertmer, 2005). Coley et al. (2015) called for increased professional development for teachers regarding relevant usage and suggested field trips or observations for teachers to see the progressive use of technology in classrooms from their surrounding areas.

King et al. (2019) explored the methods of teaching new or emerging AFNR technologies by 47 AFNR teachers in Michigan. Through an online Qualtrics® survey, teachers completed a needs assessment by reading descriptions of 15 new and emerging AFNR technologies, then rating both the importance of each technology and their competence teaching it in their classroom or laboratory. The teachers were also asked to describe the methods used in teaching each of the technologies and to rate the level of student engagement when they taught each technology.

The 15 new and emerging technologies from the King et al. (2019) study were selected by a panel of experts from various AFNR industries. The panel identified the 15 technologies they believed would have the most potential to impact AFNR in the next 25 years. Since the King et al. study was one of the first to evaluate how teachers utilize specific AFNR technologies in their classrooms, we adapted their instrument to measure students' openness and preparedness for 10 of the 15 technologies in our study.

Teachers from the King et al. (2019) study rated the overall importance of the technologies, as well as their competence with teaching each technology, to their students from 1 (*Very Low*) to 5 (*Very High*). Teachers identified genetic modification to be the most important ($M = 4.06$); however, the teachers were most competent in teaching value-added processes ($M = 3.50$). In the areas of blockchain technology ($M = 5.63$), unmanned aerial vehicles ($M = 5.61$), and precision agriculture sensors ($M = 5.21$), teachers viewed the technologies as important, but felt the least competent teaching these technologies in the classroom. The current study used results from the King et al. teachers to explore students' self-perceived competence and use of technology in and out of the classroom or laboratory.

Theoretical Framework

Diffusion of Innovations

Rogers' (2003) Diffusion of Innovations Theory has been used extensively in agriculture to frame how people process information about an innovation and make the decision whether to adopt it. Rogers proposed the innovation-decision process consists of five stages: (a) knowledge or awareness, when the individual is initially exposed to the innovation, (b) persuasion, when the individual seeks more information about the innovation, (c) decision, when the individual decides to accept or reject the innovation, (d) implementation, when the individual employs the innovation and its usefulness, and (e) confirmation or continuation, when the individual decides whether or not they will continue to use the innovation. Rogers further stated socioeconomic characteristics, personality variables, and communication behaviors influence the first stage. The knowledge/awareness stage was the focus of this study.

Teachers can have a great impact on whether their students move through the beginning stages of Rogers' theory. Roberts and Edwards (2020) viewed the first two stages in-depth and proposed an expansion to the Diffusion of Innovations model to include Lewin's (1943) conceptualization of resistance to change. Lewin's (1943) conceptualization viewed the personal, institutional, and societal forces that either drive or restrain the knowledge-building process. Roberts and Edwards believed this expansion could provide agricultural educators with a process for overcoming knowledge deficiencies among their learners when it comes to teaching more complex material in the classroom or laboratory. Smith et al. (2018) found Agricultural Education teachers were willing to adopt new technologies to enhance student learning in their classrooms. Teachers who are slower to adopt new technologies; however, could have a negative impact on students' awareness of new technology existence and use in AFNR. Teachers could also be apprehensive toward teaching about certain technologies that could be perceived as controversial in their classrooms. For instance, Lamm et al. (2020) studied public perceptions of genetic modification (GM). Using Rogers' theory, Lamm et al. found prior knowledge about GM minimized negative perceptions regarding GM in the decision-making process.

Roberts et al. (2009) used Rogers' Diffusion of Innovations theory to frame their study of Hispanic students' engagement in School-Based Agricultural Education and FFA. Of their six interventions with key stakeholders, four addressed the knowledge stage by providing experiences, information, and educational materials. The authors concluded teacher participation in FFA activities increased and the interventions were a positive influence on these Hispanic students' FFA involvement.

Career Construction Theory

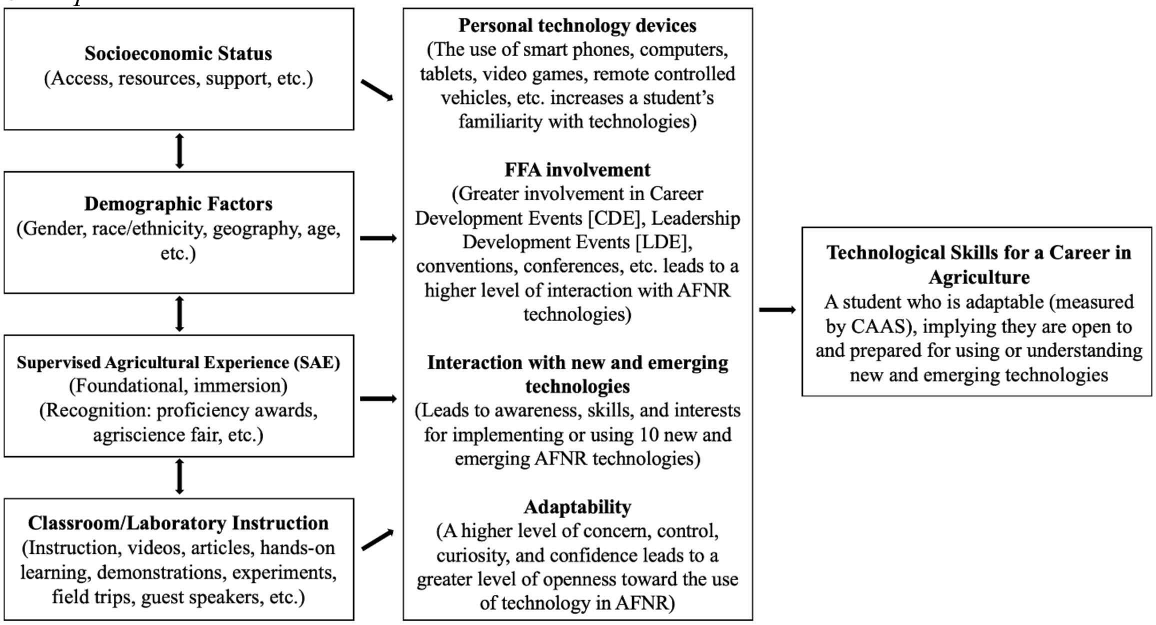
Savickas' (2005) Career Construction Theory addresses an individual's career development pathway as a function of their adaptability. People integrate into social environments through adapting to the societal expectations of how they should work, play, and develop relationships to sustain themselves (Savickas, 2005; Savickas et al., 2009). Career Construction Theory explains those interpersonal processes that drive an individual's behavioral direction or meaning. As it relates to the openness and preparedness of FFA members toward the selected new and emerging AFNR technologies in the current study, "adaptability resources should be viewed as self-regulatory, psychosocial competencies that shape adaptive strategies and actions aimed at achieving adaptation goals" (Savickas & Porfeli, 2012, p. 663). Each individual's adaptability is fueled by four constructs: (a) concern, as it relates to preparing for the future, (b) control, as it relates to responsibility and self-discipline, (c) curiosity, as it relates to exploration and seeking information, and (d) confidence, as it relates to overcoming obstacles (Savickas & Porfeli, 2012). Eshelman's (2013) study used Career Construction Theory to understand the impact of socioeconomic status (SES) and social class on the adaptability of rural high school students in Illinois. Eshelman found a positive relationship between career adaptability and SES. Dodd (2013) also used the theory to study the career aspirations, maturity, and decision-making self-efficacy of Texas 4-Hers. Results showed a positive impact on students' career choices and development due to their involvement in the Texas 4-H program. The current study used the Career Construction Theory to evaluate FFA members' adaptability and its correlation between openness and preparedness.

Conceptual Framework

The literature review and theoretical framework provided the foundation for this study's conceptual framework. Facilitating factors influencing an FFA members' access to and support for using and interacting with technology include SES, demographics, Supervised Agricultural Experiences (SAE), and classroom laboratory instruction. The FFA members' use of personal technology devices, FFA involvement, interactions with technologies, and adaptability influence their likelihood of progressing through Rogers' (2003) stages of adoption for new and emerging AFNR technologies. These lead to an FFA member who has the technological skills for a career in agriculture defined as a student who is adaptable, open, and prepared for using or understanding new and emerging AFNR technologies. See Figure 1 for a visual representation of the conceptual framework.

Figure 1

Conceptual Framework



Purpose & Research Questions

The purpose of this study was to identify the openness, preparedness, and adaptability of the National FFA Organization's 2020-2021 high school senior members toward 10 selected new and emerging technologies in AFNR. The following research questions were answered through an online quantitative study of 12th grade members of the National FFA Organization:

1. How knowledgeable is the population about the 10 selected new and emerging AFNR technologies?
2. What levels of openness and preparedness toward the 10 selected new and emerging AFNR technologies are present within the population?
3. What degree of adaptability is present within the population?
4. Does adaptability vary by demographics within the population?
5. Are openness, preparedness, and adaptability correlated for this population?

Methods

An online Qualtrics® survey was developed using a descriptive research design with five sections: (1) Openness and Preparedness, (2) Adaptability, (3) FFA Involvement, (4) Academic Success, and (5) Demographics. The data analyzed were part of a larger study with data from sections (1), (2), and (5) reported in this article. The openness and preparedness section used a model developed by King et al. (2019) to evaluate students' perceptions of new and emerging technologies in AFNR. The adaptability section was the CAAS – International Version 2.0 (Savickas & Porfeli, 2012). We developed the demographic section with input from National FFA Staff members and included race or ethnicity, age, gender identity, rural-urban commuting area classification, the receipt of free and reduced lunch as a measure of social economic status, internet access, and access to technological devices. The Purdue University Institutional Review Board gave approval to conduct the study.

Openness and Preparedness

Within this section, 10 selected new and emerging AFNR technologies were described (see Table 1), and respondents rated their openness toward the technologies' use and application in the AFNR field as well as their preparedness for using the technologies in a classroom, laboratory, or in their future career. Both openness and preparedness were rated from 1 (*Very Low*) to 5 (*Very High*). The King et al. (2019) study explored how new and emerging AFNR technologies were being implemented in the Michigan Agricultural Education curriculum. Their study viewed technology from the perspective of teachers, while our study viewed FFA members' openness and preparedness toward AFNR technologies. The definitions of each technology listed in this section were adapted from the King et al. (2019) instrument.

King et al. (2019) used a panel of five industry experts to identify 15 new and emerging AFNR technologies. We chose to focus our study on the 10 highest rated technologies. We narrowed the list by eliminating the five technologies teachers had the lowest competency teaching, the lowest perceived importance, and the lowest student engagement. The five technologies we eliminated were (a) Blockchain Technology, (b) Digital Twinning, (c) Rapid Iterative Selective Breeding (RISB), (d) 5G Internet, and (e) Cultured/In-Vitro Meat. In consultation with the lead researcher for the King et al. study, we modified the descriptions for the 10 selected technologies. The modifications to improve readability and lessen time to complete the survey shortened the descriptions and used words more appropriate for high school students.

Openness and preparedness were operationally defined in consultation with National FFA Staff. These two attributes of adaptability were chosen based on National FFA Staff interactions with employers in agricultural companies, discussions connected with the Blue Room at the National FFA Convention, and other technology-related discussions. For this study, someone whose open-mindedness is very high was defined as being receptive to the use and application of new and/or emerging AFNR technologies. This person is comfortable with these technologies being included in the AFNR field. For this study, someone whose preparedness for using new and/or emerging AFNR technologies is very high was defined as being able to use the technology in a classroom, laboratory, or future career. This person will be organized and ready to use the technologies either by themselves or with the aid of a partner or professional.

Table 1

New and Emerging AFNR Technologies and Descriptions

AFNR Technology	Description
Closed Ecological Systems	Where any waste products, such as animal waste, must go back into the ecological system itself.
Farm Management Apps	Digital applications that can be used to help manage a farm.
Genetic Modification	The insertion of genes from other organisms to provide a benefit.
Livestock Biometrics	Measurement systems, such as RFID tagging or similar sensor methods, used to monitor animal health or recommend changes to feeding rations.
Precision Agriculture Sensors	Sensors collecting and recording data about air, soil, crop, and infrastructure health for agricultural use and efficiency.
Satellite Imaging	Using images from satellites to show impactful trends or predict future change.

Table 1

New and Emerging AFNR Technologies and Descriptions, continued…

Synthetic Biology	The artificial design of biological systems and living organisms such as the creation of new enzymes for waste processing for industry or research.
Unmanned Aerial Vehicles (UAVs)	Drones that are used to take pictures/video, access sensors, and collect data on the farm.
Value-Added Processes	The expansion of farm activities to create products, such as ethanol, that would normally happen beyond the farm.
Vertical Farming	Raising crops and food in a building, such as an office, warehouse, or rooftop garden, to increase access to food in urban areas.

Note. Adapted from "New and Emerging Technologies: Teacher Needs, Adoption, Methods, and Student Engagement," by L. G. King, A. J. McKim, M. R. Raven, & C. M. Pauley, 2019, *Journal of Agricultural Education*, *60*(3), 277–290. (https://doi.org/10.5032/jae.2019.03277).

Next, the respondents indicated whether or not they had come in contact with any of the 10 new or emerging technologies by selecting either yes or no. If a respondent selected yes to any of the technologies, a follow-up question was presented for them to indicate the method of their use or contact with that technology from a list that included an agriculture classroom or laboratory, a non-agriculture classroom or laboratory, their supervised agricultural experience (SAE), somewhere in their FFA experience, or outside of school.

Adaptability

Respondents completed the Career Adapt-Abilities Scale (CAAS) Career Adapt-Abilities Inventory – International Version 2.0. This 24-item scale was developed by a team of psychologists from 13 countries to measure adaptability with a scale reliability of 0.92 (Savickas & Porfeli, 2012). It has been cited by more than 580 publications (Scopus, n.d.). Since publishing the CAAS, Porfeli and Savickas (2012) have tested its validity in a number of countries, with the United States average adaptability of 3.81 out of 5 similar to the International average of 3.84. The 24-items from the CAAS are split into four subscales to measure the respondents' concern, control, curiosity, and confidence. Participants respond by indicating their ability for each item in the scale from 1 (Not Strong), 2 (Somewhat Strong), 3 (Strong), 4 (Very Strong), 5 (Strongest). The participants' total score from the inventory is a representation of their adaptability.

Participants

The population for the study were 12th grade members of the National FFA Organization for the 2020-2021 school year (N = 84,796). Selecting this age group provided us with the greatest chance of having participants with three or more years of experience in the organization, although students with less experience were not excluded. The target population's age ranged from 16-20 years old. For those under the age of 18 who chose to participate, the Purdue University Institutional Review Board (IRB) approved using electronic consent forms emailed to the parents or guardians of those subjects. Assent and consent procedures from the Copeland (2019) study were utilized.

No subject was excluded from the study based on their gender identity, ethnicity, or health status, but participation was limited to FFA members in the 12th grade for the 2020-2021 academic year. A list (N = 86,727) of members' email addresses was obtained from the National FFA Organization for the students that met the age criteria. After deleting duplicate and invalid email addresses, the final census was 84,796.

A participation incentive drawing was used for both FFA members and their parent/guardian providing consent. At the end of data collection, 50 respondents and 25 parent/guardian email addresses were randomly selected to receive a $20 Amazon gift card. The electronic gift cards were distributed by National FFA Staff to the recipients.

Data Collection

A pilot study was conducted with members of the Indiana FFA Executive Committee. These FFA members were selected as they tend to be high school juniors to college freshmen. They also tend to be active in chapter, district, state, and national FFA events and activities ensuring they could detect question wording confusion or errors. A link to the pilot study questionnaire was emailed to all 23 Indiana FFA Executive Committee members. After the initial email and two reminder emails, 14 responded for a 61% response rate. Isaac and Michael (1995) recommended 10-30 respondents for a pilot study. Based on responses, some questions were ordered differently, and questionnaire aesthetics were modified. The 14 respondents completed the survey in a mean of 16 minutes.

An email was sent on September 18, 2020, to FFA advisors with FFA members in the study. The email alerted the FFA advisors their senior FFA members would be receiving a request to participate in the study. Following this alert to FFA advisors, the questionnaire was distributed via Qualtrics® to all 84,796 FFA member email addresses. However, a Qualtrics® maximum email limit prevented sending to all participants at one time. Therefore, the email addresses were divided into two equal groups with Group 1 receiving the initial contact on September 24, 2020, and Group 2 on October 1, 2020. Reminders were emailed two weeks apart concluding with Reminder 3 to Group 2 on November 12, 2020. Data collection ended on November 23, 2020.

Data Analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS). Means, frequencies, and percentages were calculated for all variables. For statistical analyses, significance level was set a priori at 0.05. ANOVA analyses were conducted for Adaptability (CAAS) and gender, ethnicity, SES (free/reduced lunch), and RUCA classification. Correlation analyses were conducted between overall openness, overall preparedness, and adaptability.

Findings

Response Rate

Of the 71,625 usable emails defined as those that did not bounce or fail, 10,060 respondents opened the questionnaire and made at least one response. There were 2,265 completed responses. However, 737 did not have an accompanying consent or parental/guardian consent. Therefore, the final usable responses were 1,528 which is a 3.2% response rate. Using Lindner et al. (2001) conventions of comparing early wave responses versus last wave responses, analyses were conducted on variables of interest. There were no statistically significant differences. Therefore, we concluded early and late respondents were from the same population. There was some indication late respondents were similar to non-respondents (Lindner et al., 2001); however, with the low response rate generalizations to the entire population of high school senior FFA members should not be made.

Demographic Profile

A majority of respondents were female (69.0%) with 30.5% identifying as male and 0.5% identifying as non-binary or non-disclosed. Respondents identified their race/ethnicity as White (84.4%), Hispanic/Latino/Latinx (8.6%), Black/African American (2.6), 1.6% selected American Indian/Alaska Native (1.6%), Asian (0.8%), 0.2% selected Native Hawaiian/Other Pacific Islander (0.2%), and 1.8% preferred not to answer. We wanted to be as noninvasive as possible in measuring SES, so we asked respondents if they received free or reduced lunch at their schools. This resulted in 38.9% indicating they received free or reduced lunch, 56.0% who indicated they did not, and 5.1% who preferred not to answer. Using respondents' zip codes and the United States Department of Agriculture, Economic Research Service (2018, 2019, 2020) Rural-Urban Commuting Areas settlement classifications, we determined respondents' rural/urban classification by population size of the area (United States Census Bureau, 2010). The respondents were classified as: 48.0% Metropolitan Areas with populations of 50,000 people or more, 22.4% Micropolitan Areas with populations of at least 10,000 to 49,999 people, 15.4% Small Towns with populations of at least 2,500 to 9,999 people, and 14.2% Rural Settlements defined as outside of all other classification boundaries.

Research Question 1

Respondents were asked to identify types of internet access they had at home and the types of personal technology devices they used (See Table 2). Respondents were instructed to select all that applied. Two-thirds of respondents identified access to a cell phone data plan. Respondents identified access to cable, fiber, and satellite internet; however, 2.1% reported their internet access was dial-up and 2.4% identified no internet access. Almost all respondents identified they had access to a smart phone and a computer.

Table 3 describes how many respondents had ever used or come in contact with each of the 10 new and emerging technologies. Table 4 shows whether the respondents used or came in contact with the technologies in an agriculture classroom/laboratory, a non-agriculture classroom/laboratory, in their SAE, in their FFA experience, or outside of school and not FFA- or SAE-related.

Table 2

Respondents' Access to Internet and Use of Personal Technology Devices (n = 1,528)

		f	% of Respondents
Internet Access (Select all that apply)	Cell Phone Data Plan	1,047	68.5
	Fiber Internet	238	15.6
	Satellite Internet	529	34.6
	Cable Internet	564	36.9
	Dial-Up Internet	32	2.1
	None	36	2.4
Personal Technology Devices (Select all that apply)	Smart Phone	1,484	97.1
	Computer	1,364	89.3
	Tablet	463	30.3
	Video Games	516	33.8
	Remote Controlled Vehicles	130	8.5

Table 3

Technologies the Participants Have Ever Used or Come in Contact (n = 1,528)

Technologies (Select all that apply)	*f*
Farm Management Apps	789
Vertical Farming	754
Genetic Modification	610

Table 3

Technologies the Participants Have Ever Used or Come in Contact (n = 1,528), continued…

Satellite Imaging	564
Unmanned Aerial Vehicles (UAVs)	523
Livestock Biometrics	509
Precision Agriculture Sensors	408
Closed Ecological Systems	374
Value-Added Processes	186
Synthetic Biology	161

Table 4

Method of Contact that Applies to Participants Experiences with the Technologies (n = 1,528)

Method of Use or Contact (Select all that apply)	*f*
Agriculture Classroom/Laboratory	3,071
FFA Experience	1,900
Supervised Agricultural Experience (SAE)	1,346
Non-Agriculture Classroom/Laboratory	1,282
Outside of School (Not FFA or SAE)	2,774

Research Question 2

Respondents rated their openness and preparedness from 1 = very low to 5 = very high. The highest rated technology for both openness and preparedness was vertical farming and the lowest for both was synthetic biology (see Table 5). A composite mean was computed to create scales. The Openness scale had a Cronbach's Alpha of .84 and the Preparedness scale had a Cronbach's Alpha of .85 indicating a good level of internal consistency. The Openness Scale was neutral approaching high (*M* = 3.82, *SD* = .80). The Preparedness Scale was low approaching neutral (*M* = 2.96, *SD* = .93) (See Table 6).

Table 5

Openness and Preparedness Means for the Technologies (n = 1,528)

	Openness (M)	*Preparedness (M)*
Vertical Farming	4.09	3.48
Farm Management Apps	4.20	3.35
Unmanned Aerial Vehicles (UAVs)	3.99	3.22
Livestock Biometrics	4.09	3.19
Precision Agriculture Sensors	4.13	3.18
Satellite Imaging	3.91	2.99
Closed Ecological Systems	3.58	2.85
Genetic Modification	3.59	2.75
Value-Added Processes	3.45	2.55
Synthetic Biology	3.35	2.39

Table 6

Openness and Preparedness Overall Mean Scores

	N	*M*	*SD*
Overall Openness Score	1526	3.82	.80
Overall Preparedness Score	1524	2.96	.93

Research Question 3

Respondents rated their adaptability from 1 = not strong to 5 = strongest. The composite mean Career Adapt-Abilities Scale was approaching very strong (Savickas & Porfeli, 2012). The adaptability score was composed of the four constructs: (a) concern, $M = 3.85$, $SD = .71$; (b) control, $M = 3.82$, $SD = .70$; (c) curiosity, $M = 3.65$, $SD = .76$; and (d) confidence, $M = 3.91$, $SD = .72$. Each of these constructs explains a specific factor of the respondents' adaptability. This led to an adaptability mean of $M = 3.80$, $SD = .60$ (See Table 7). For this study, the CAAS adaptability scale had a Cronbach's alpha of .92.

Research Question 4

Table 8 shows the respondents' composite CAAS means by demographics. The ANOVA comparison of means was not significant for any of the demographics at the .05 level.

Research Question 5

Table 9 shows correlations among the three overall scales used for this study. All correlations were statistically significant at the a priori .05 level. According to the effect size interpretation suggested by Kotrlik et al. (2011), Openness and Preparedness had a medium, positive correlation with each other. Adaptability had small, positive correlation with both Openness and Preparedness.

Table 7

Career Adapt-Abilities Scale – International Version 2.0 (n = 1,528)

	Minimum	Maximum	*M*	*SD*
Concern Score	1	5	3.85	.71
Control Score	1	5	3.82	.70
Curiosity Score	1	5	3.65	.76
Confidence Score	1	5	3.91	.72
Career Adapt-Abilities Scale (CAAS) Score	1	5	3.80	.60

Note. Possible scale values: 1 = not strong. 2 = somewhat strong. 3 = strong. 4 = very strong. 5 = strongest. Savickas and Porfeli (2012).

Table 8

Comparisons of CAAS and Demographics

		N	*CAAS*
Gender Identity	Female	1037	3.81
	Male	452	3.81
	Non-Binary	6	3.91
	Non-disclosed	2	3.31
Race/Ethnicity	American Indian or Alaska Native	24	3.74
	Asian	12	3.34
	Black or African American	38	3.84
	Hispanic, Latino, or Latinx	129	3.81
	Native Hawaiian or Other Pacific Islander	3	3.86
	White	1264	3.82
	I prefer not to answer	27	3.53
Free/Reduced Lunch	Yes	585	3.82
	No	840	3.81

Table 8

Comparisons of CAAS and Demographics, continued…

	Prefer not to answer	72	3.74
RUCA Classification	Metropolitan	719	3.84
	Micropolitan	337	3.78
	Small Town	231	3.79
	Rural	210	3.77

Note. ANOVA comparisons were not significant at the a priori .05 level.

Table 9

Correlations Between Overall Openness, Overall Preparedness, and Adaptability

	Overall Openness	Overall Preparedness	Adaptability
Overall Openness			
Pearson's r	1	.49	.25
p-value		.000	.000
Overall Preparedness			
Pearson's r	.49	1	.26
p-value	.000		.000
Adaptability			
Pearson's r	.25	.26	1
p-value	.000	.000	

Note. Significant at the .05 level.

Limitations

Because of the low response rate (3.2%), these findings apply only to the respondents. An early/late response comparison showed no statistical differences. This study can provide baseline data for comparison by future studies. With students completing much of their schoolwork online in 2020, they may have been overwhelmed with email and computer time when they received an invitation for this online survey leading to a greater number of non-respondents than expected.

Conclusions and Discussion

Respondents had access to a smart phone (97.1%) and a cell phone data plan (68.5%) indicating they have the ability to become knowledgeable and aware of new and emerging technologies outside of school. This supports recommendations by others (Coley et al., 2015; Smith, Blackburn, et al., 2018; Smith, Stair, et al., 2018; Smith et al., 2019) that agriculture teachers must utilize smartphones and apps as learning tools. However, agriculture teachers must be aware of the one-third of their students who do not have cell phone data plans and the approximately 5% who have slowed or no internet access.

All 10 selected new and emerging Agriculture, Food, and Natural Resources (AFNR) technologies had respondents who had interacted with the technologies. This aligns with the King et al. (2019) study as these 10 were the highest rated for teacher competency, perceived importance, and student engagement for that study. Approximately half of respondents had interacted with farm management apps and vertical farming. Respondents had most frequently interacted with the technologies in an agriculture classroom/laboratory or outside of school (not FFA or SAE). This implies agriculture courses are an appropriate setting to introduce these technologies to students and provide opportunities for students to use the technologies. However, it also implies agriculture teachers are not fully utilizing FFA and SAE to increase students' knowledge of and ability to use new and emerging agricultural technologies.

Respondents had an Openness scale mean of 3.82 indicating an openness to the 10 selected new and emerging technologies. However, respondents had a lower Preparedness scale mean of 2.96 indicating they were less than fully prepared. For five of the 10 technologies, their perceived Preparedness was approaching "low" with three of those also with the fewest number of participants having used or come in contact with the technology. This implies these respondents have entered Rogers (2003) knowledge/awareness stage, but they need more experiences and education to be able to use the technologies on their own or with the aid of a partner. This supports previous research indicating agriculture teachers need knowledge and experiences to influence adoption of technologies by their students (Roberts & Edwards, 2020; Roberts et al., 2009; Smith et al., 2018). These findings lead us to conclude these members of the National FFA Organization will be open to and adaptable for understanding and using the rapid and constant changes to technologies in Agriculture, Food, and Natural Resources.

The composite CAAS (3.80) approached a very strong level of adaptability, indicating this group of respondents are adaptable. When looking at the four constructs – concern (3.85), control (3.82), curiosity (3.65), and confidence (3.91) – curiosity was the lowest. Curiosity is the construct that reflects an individual's interest in exploring and seeking information about a topic (Porfeli & Savickas, 2012). The lower level of curiosity related to the other three constructs could explain why respondents were less prepared to use the 10 selected AFNR technologies as it indicates they may not seek out information on their own. Therefore, these respondents may need teachers to introduce them to technologies and guide them through becoming knowledgeable about the technologies to move the respondents through Rogers (2003) knowledge/awareness stage and into the other stages.

There were no differences for overall Openness, Preparedness, and Adaptability scales by demographics indicating other facilitating factors (See Figure 1) may have a stronger influence than demographic factors. There was a significant and positive relationship between adaptability, openness, and preparedness. A more open student toward new and emerging AFNR technologies, tends to be more prepared for using these technologies. Furthermore, when students are adaptable, they tend to be more open to and prepared for technologies in AFNR.

Savickas et al. (2009) were convinced significant learning occurs when students are able to exercise and practice new skills. Sometimes, however, teachers themselves may not be equipped with the resources needed to teach certain skills in their classrooms or laboratories. This supports the findings of Coley et al. (2015) and King et al. (2019) that teachers need professional development related to new and emerging AFNR technologies to help them ensure students are more prepared for using the technologies. Students are open to the implementation of these technologies in AFNR; therefore, teachers need to be equipped with the training and resources required to advance their students' abilities to use them in different settings.

Recommendations

Recommendations for Practice

Coley et al. (2015) and King et al. (2019) recommended implementing training sessions for teachers related to the classroom use of instructional technologies and AFNR technologies. These training sessions would encourage a greater level of immersive learning experiences in agriculture courses. Given the findings and conclusions from our study with high school seniors, we recommend demonstrations, field trips, and how-to videos that could increase FFA members' preparedness for using AFNR technologies on their own or with the aid of a partner. We recommend agriculture teachers continue to introduce and use these 10 selected technologies in their School-Based Agricultural Education courses. Additionally, they should take advantage of opportunities to emphasize and use the technologies in FFA events and activities as well as provide advice and suggestions for students to use the technologies in their SAE programs. We recommend National FFA Career Development Events (CDEs) associated with the content of these 10 technologies incorporate the knowledge of and possible use of the technologies into the competitions. We also recommend National FFA review proficiency awards to align scoring rubrics with appropriate use of technologies related to the associated Supervised Agricultural Experience (SAE).

Recommendations for Research

Researchers conducting studies with high school seniors as participants, should consider collecting data in the spring semester rather than the fall to maximize the number of participants who may be 18 years old or older. The greatest number (32.5%) of our excluded participants were under the age of 18 and never got parental consent for the study. This study and Copeland (2019) were census studies with greater than 60,000 in the population. Both studies had low response rates. We recommend conducting sampling studies instead of a large-scale census study as a sampling study should yield higher response rates with greater validity. Future research is needed to extend this study and look at the remaining four stages of the Diffusion of Innovations Theory (Rogers, 2003) for high school students and these 10 AFNR new and emerging technologies. We studied FFA members. Future research is needed to see if School-Based Agricultural Education students who are not FFA members are also adaptable and open to these 10 AFNR new and emerging technologies.

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