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Utilizing teaching technologies for higher education in a post-COVID-19 environment

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Abstract

Higher education can use technology in the classroom to meet students where they are and reduce the digital divide. Recent events with the COVID-19 pandemic forced schools to rely on multiple forms of technology and underlined the priority for its adoption and effective use. Therefore, understanding the options and role that easily accessible applications can play in the on-ground or online classroom is an important research need. This study assessed graduate students' perceptions of five different types of technology that were incorporated in the classroom across six different semesters. These technologies included classroom response systems, a mobile communication app, and Twitter, blogging, and video production assignments. Overall, the majority of students identified positive characteristics of all of the technology used. With respect to learning, almost all students self-identified increases in their learning from the classroom response systems (88%), Twitter discussion (81%), blogging (93%), and video production (90%). The methods used to incorporate this technology can be applied to multiple disciplines with few or no changes, thereby making these options for many instructors interested in engaging students in digital learning environments.

1 | INTRODUCTION

Using technology in the classroom is not new but it is a continuously evolving practice with new methods for incorporating new types of technology. Currently, there are a number of options for using technology to assist or complement traditional teaching methods. These can include the use of applications such as social media and mobile communication systems, mobile classroom response systems, and video technology. Researchers have observed the use of information and communication technology (ICT) as a component

of classroom instruction to be beneficial to student learning (Bernard, Borokhovski, Schmid, Tamim, & Abrami, 2014; Means, Toyama, Murphy, & Baki, 2013; Vahedi, Zannella, & Want, 2019).

Social media can include a host of platforms, such as blogging or micro-blogging, for learning and communication. In general, social media have been found to have a positive role in education where it can create a more open environment for engagement with the instructor or between students (Al-Rahmi, Alias, Othman, Marin, & Tur, 2018; Dunn, 2013; Ratneswary & Rasiah, 2013) that can enhance student participation and preparation in the class (Arslan, 2018). Social media can also extend the learning resources beyond the classroom (Grudz, Haythornthwaite, Paulin, Gilbert, & del Valle,

Abbreviations: CRSs, classroom response systems; ICT, information and communication technology.

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2018) and increase the learning experience outside of classroom contact hours (Means et al., 2013). Implementing social media within a traditional teaching structure creates a more learner-centered environment (Chawinga, 2017) and can help students develop their communication skills (Kassens, 2014; Pineteh, 2012; Waycott et al., 2010) along with digital literacy (Willems, Adachi, Bussey, Doherty, & Huijser, 2018). Lastly, social media creates an active, collaborative classroom learning environment that may contribute two of the three components (cognitive presence, social presence) of the Community of Inquiry model, which is used by numerous scholars for computer-based conferencing in education (Garrison, Anderson, & Archer, 2010; Willems et al., 2018).

Although overall observations utilizing social media in the classroom are positive, there are some who have found negative associations. Lau (2017) found that nonacademic use of social media and social media multitasking were negatively related to academic performance and Kuppaswamy and Narayan (2010) believed that social media distracted students' attention toward nonacademic purposes. Others observed either no effect or a decrease in student engagement or achievement (Dyson, Vickers, Turtle, Cowan, & Tassone, 2015; Flanigan & Babchuk, 2015) or indicated that students struggle with evaluating suspect information on social media (Wineburg, McGrew, Breakstone, & Ortega, 2016). Other issues in using social media for academic purposes include concerns about privacy, wi-fi or internet capabilities, lack of skills for using the technology, and resistance to change (Chawinga, 2017; Cho & Rangel, 2016; Wheeler, 2010). In some cases, academics have been found to be lagging in social media adoption (Manca & Ranieri, 2016), which may reduce their ability to effectively implement this technology. When students identify that communication technologies are being used effectively by their instructors, there is greater learning and motivation (Waldeck & Dougherty, 2011). It is also important for these technologies to be implemented in a way that is authentic and reflects the kind of use that will be expected in the workplace (Willems et al., 2018). In general, students utilize social media regularly in their daily lives and by incorporating this technology into the classroom, instructors can meet students where they are and where they are comfortable. By not doing so, it may artificially limit teaching capacity and also lead to a greater divide between higher education institutions and the public at large (Willems et al., 2018).

Another example of technology use in the classroom includes classroom response systems (CRSs) that can be used for teaching or testing purposes. These systems have largely moved from classroom-based systems, where clickers must be purchased or provided, to mobile-based systems using smartphones. The CRSs have been shown to be useful in providing greater engagement and increasing attention (Wu, Wu, & Li, 2019) and the anonymity provided by CRSs helps to

Core Ideas

- Few studies focus on multiple teaching technology interventions.
- This study focused on student perceptions across six semesters.
- Most students identified positive perceptions and increased learning from teaching technologies.
- The results and strategies may be useful for enhancing community in online courses.
- The technologies incorporated are applicable to many different disciplines.

create this greater engagement (Freeman, Blayney, & Ginns, 2006; Raes, Vanderhoven, & Schellens, 2015). They can also be used as an assessment tool, allowing instructors to personalize instruction for a class based on their specific needs (Beatty & Gerace, 2009; Weerts, Miller, & Altice, 2009). The CRSs have also been found to improve student attendance and motivation (Dufresne, Gerace, Leonard, Mestre, & Wenk, 1996; Salemi, 2009), allow students to take greater responsibility for their learning (Beatty, 2004), and break up long lectures (Gould, 2016). When mobile-based CRSs have been implemented, students have found them fun and innovative to use (Wu et al., 2019) and preferred them over hand-held clickers (Imazeki, 2014). Challenges include those that are teacher-based, such as question development, inclusion of all required material, learning how to implement the technology and engaging with instant student responses, and student-based challenges, such as discussion of multiple perspectives, understanding a new way to learn, and the negativity of feeling monitored (Kay & LeSage, 2009). With the mobile-based systems, challenges of wi-fi or cellular service connections and potentially distracting behaviors when incorporating smartphones in the classroom are similar to those identified with social media (Imazeki, 2014).

The use of video technology can also be incorporated into the classroom to create engaging opportunities for students to enhance communication skills and increase digital literacy. Rather than simply viewing videos, active involvement in their development can provide these learning experiences. They can allow students to take a more active role in their learning and increase motivation and positive emotions (Multisilta, 2014; Pirhonen & Rasi, 2017). These positive emotions can include increases in interest and enthusiasm (Hakkarainen & Vapalahti, 2011). Using video production can also increase students' presentation skills through organization, delivery techniques, and speech content development (Liu, 2016).

According to Vahedi et al. (2019), there is little research to support different forms of information and communication

technology in education and digital literacy has been identified as an important skill that should be implemented as a graduate outcome (Willems et al., 2018). To our knowledge, virtually no studies have concentrated on the integration and analysis of multiple modes of technology within a higher education classroom. This research focused on the implementation of (a) social media, through Twitter and blogging; (b) mobile communication technology, through Slack or GroupMe; (c) classroom response systems, through clickers or PollEverywhere; and (d) digital video production in a graduate-level course in an agricultural sciences program. The objectives were to identify the student-perceived advantages and disadvantages of the technology and their perceptions of how the technology affected their learning.

2 | MATERIALS AND METHODS

2.1 | Course technology

The technology was implemented into a graduate-level Research Methods course at Tennessee State University over six semesters (Spring 2017, Fall 2017, Spring 2018, Spring 2019, Fall 2019, and Spring 2020). Each semester had between 9 and 23 students (9 students in Spring 2017, 23 students in Fall 2017, 13 students in Spring 2018, 16 students in Spring 2019, 21 students in Fall 2019, and 13 students in Spring 2020) for a total of 95 students. The course largely focuses on technical writing in the form of developing a research proposal for their thesis. The Twitter, blogging, and video production assignments were implemented to help enhance students' nontechnical communication skills, which is another objective within this course.

The Twitter assignment was first used in the classroom in Fall 2014 and students were required to use their existing Twitter account or create a new one for the assignment. With this account they participated in one Twitter discussion hosted by other agriculture-related groups (#agchat or #agbookclub). Starting in Spring 2018 students were required to participate in at least two Twitter discussions. The discussions included #agchat in Spring 2017, Fall 2017, and Spring 2018 and #agbookclub in Spring 2019, Fall 2019, and Spring 2020. The discussions were both run similarly where the group moderator would begin asking questions on a regularly scheduled day and time using specific question numbers and the group hashtag and participants would respond with the specific answer number and the group hashtag. Once students participated in the discussion, the assignment required them to answer a series of questions related to what they learned, what they contributed to the discussion, and if they found that type of discussion interesting or helpful.

The blogging assignment was first used in the course in Fall 2016. The assignment required students to create their

own blog site and post to it at least two times per month for 3 months. Each post had to be at least 175 words and include an image. Posts could be related to things students were learning in the course or other courses, work they were performing in their thesis research, or other agriculture-related topics. A list of all blog web addresses was provided to students so they could visit each other's blogs. In the Spring 2020 semester, all students posted to a class blog rather than their own individual blogs and students were required to post at least two comments on other classmates' posts.

The video production assignment was implemented in Fall 2018 and required students to create a 1–2 minute how-to video that demonstrated the steps involved in an agriculture-related procedure, such as methods used in the laboratory or the field. Examples of free video-editing software were included with the assignment instructions. The videos were viewed in class and graded by students and the instructor for criteria like video and audio quality and subject interest and clarity. The videos were then uploaded to a YouTube channel and the student with the video that received the highest number of views within a certain time period received extra points on the assignment. Students were provided with links to their videos and encouraged to promote them, particularly using their classroom Twitter accounts.

A classroom communication app, Slack, was first implemented in the classroom in Fall 2017 to allow students to interact more with the instructor and get faster feedback to questions. The GroupMe app was used beginning in Fall 2019 as it was thought more students were already using this app.

Clickers were originally implemented in the course in 2011 and transitioned over to PollEverywhere in Spring 2019 once it seemed that all students had smartphones. The CRSs were used as a pre-test to get students thinking about the topics that would be covered during the class and as a post-test at the end of class where the correct/incorrect answers were discussed.

2.2 | Survey

An online survey was developed in Qualtrics and a link to the survey was sent to students after final grades for the course were posted. The survey included a consent form and was approved by the Tennessee State University Institutional Review Board (HS2017-3923). In the Spring 2017, Fall 2017, and Spring 2018 semesters, the survey was made up of 11 questions that focused on what students liked and did not like about using the technology in class and self-perceptions of how the CRSs affected their knowledge of the material, how the Twitter assignment affected their knowledge of agricultural issues, and how the blogging assignments affected their communication skills. In the Spring 2019, Fall 2019, and Spring 2020 semesters, three additional survey questions were added as the video production assignment was added in

TABLE 1 Using Twitter for #agchat or #agbookclub discussions ($N = 69$)

What did you like about the #agchat (or #agbookclub) assignment?	% of respondents
Nothing	0
Learning other people's opinions on different agricultural topics	77
Learning to use Twitter	39
Communicating with others about agriculture	64
The opportunity to provide my opinions	54
It increased my awareness of different agricultural issues	58
Other:	1
Other responses included "was fun getting followers and likes"	
What did you NOT like about the #agchat (or #agbookclub) assignment?	
Nothing	43
Discussion of topics that I am not familiar with	13
The discussion was too fast	23
You could only type 140 (or 280) characters	28
Twitter was difficult for me to use	3
People did not respond to my tweets	4
Other:	7
Other responses included "engagement in one more social media," "having to make a Twitter account," "problem is that I could not type long sentences in one tweet, perhaps that was my less expertise in twitter handling," "Discussion was based on books that you need to purchase and you could get lost in the discussion if you have not read the book," and "Only [one day each week] is available to discuss. If more than one day is available, it is flexible"	
By participating in the #agchat (or #agbookclub) assignment, I believe my knowledge of agricultural issues:	
Increased significantly	49
Increased slightly	32
Remained the same	19
I did not participate in any #agchat (or #agbookclub) discussions	0

Fall 2018. Students were able to select all options that applied to them for the positive and negative attributes of the technologies. The like/dislike questions all contained an "other" prompt, which allowed students to enter their own answers. The overall response rate across all six semesters was 73% with a range of 56–85% (56% for Spring 2017, 65% for Fall 2017, 71% for Fall 2019, 77% for Spring 2018, 81% for Spring 2019, and 85% for Spring 2020). All data presented are total percentiles across the entire six-semester period.

3 | RESULTS AND DISCUSSION

3.1 | Twitter

The implementation of Twitter discussion as a course assignment was well-received by students. Students identified positive attributes of the assignment including that they

liked learning others' opinions on agricultural topics (77%), communicating with others about agriculture (64%), and/or increasing their awareness of different agricultural issues (58%) (Table 1). Additionally, one student commented, "it was fun getting followers and likes." These results are likely due to the greater interactivity and the more stimulating learning environment that Twitter can provide (Menkhoff, Chay, Bengtsson, Woodard, & Gan, 2015). Students can disseminate knowledge learned in the classroom outside and bring local knowledge to the classroom using social media (Kazmer, 2007). This is very similar to our assignment where students provided their experiences, opinions, and interests in agriculture and also were able to hear and discuss agricultural issues as part of the learning activity. A meta-analysis found that the majority of studies indicated increased learning, motivation, engagement, communication, and teaching in classrooms where Twitter was used, though only 2 of the 100 studies analyzed were from the natural or physical sciences (Malik,

TABLE 2 Blogging assignment results ($N = 69$)

What did you like about blogging?	% of respondents
Nothing	1
It made me think about my interests in agriculture	59
It helped me to organize my thoughts	65
Being able to write in a nontechnical way about agriculture	55
It improved my ability to communicate about agriculture	61
Other:	4
Other responses included “it’s the way of expressing knowledge and expression in [a] more professional way,” “Let me rant about what I was struggling with,” “Most importantly, it improves my generic writing skill other than paper”	
What did you NOT like about blogging?	
Nothing	58
Writing about myself	17
I was concerned about the public nature of the blog	16
It did not improve my communication skills	3
It was difficult to identify things to write about	19
Other:	1
Other responses included “figuring out how to share the blog without paying was difficult”	
By participating in blogging, I believe my communication skills:	
Increased significantly	55
Increased slightly	38
Remained the same	7
I did not participate in blogging	0

Heyman-Schrum, & Johri, 2019). Although our study focused on Twitter use outside the classroom, many of these characteristics were still likely involved. The Twitter activity used the hashtag feature to participate in discussion and this feature has been found by some students to increase connections and the sense of community (Bledsoe, Harmeyer, & Wu, 2014). Menkhoff et al. (2015) identified the importance of students having a voice that Twitter provides them, and our students also acknowledged this where 54% liked being able to provide their opinions. In one study, 52% of students identified that increasing their tweeting and blogging skills as a reason for participating in the social media classroom assignments (Chawinga, 2017). This is similar to the 39% of students who saw learning to use Twitter as one of the benefits of the current Twitter assignment. Using social media has also been acknowledged by others as a way to increase digital literacy (Willems et al., 2018).

When it came to negative aspects of the Twitter assignment, many (43%) found none (Table 1). Some negative comments provided by students included, “engagement in one more social media,” “having to make a Twitter account,” “Discussion was based on books that you need to purchase

and you could get lost in the discussion if you have not read the book,” and “only particular date is available to discuss, if more than one day is available, it is flexible.” The greatest dislike was related to the character limit (28%) which has been observed in other studies (Adams, Raes, Montrieux, & Schellens, 2018; Bledsoe et al., 2014) with some concerned that it could reduce students’ grammatical skills (Dhir, Buragga, & Boreqqah, 2013). Others, however, believe that the character limit can actually enhance students’ writing by forcing them to write concisely (Kassens, 2014). The next greatest dislike for students was that the Twitter discussion was too fast (23%). This has also been observed by others who found that the number of tweets could be overwhelming (Fox & Varadarajan, 2011). Students (13%) also felt discomfort in discussing topics they were not familiar with. This may relate to results from Lackovic, Kerry, Lowe, and Lowe (2017), who identified that students were reluctant to engage when an expert was participating in discussions. Additional concerns such as unfamiliarity with using Twitter (Stephens & Gunther, 2016) and not receiving feedback from tweets (Adams et al., 2018) identified in other research were low concerns in this study (3–4%). Student concerns over the level of privacy on

TABLE 3 Slack (or GroupMe) app use outside the classroom ($N = 69$)

What did you like about the Slack (or GroupMe) app (used to communicate instead of email)?	% of respondents
Nothing	7
It allowed me to interact more with my professor than email would	84
It allowed me to interact more with students in the class than email would	51
It was easier to use than email	64
It was more fun to use than email	43
Other:	4
Other responses included “it was faster to use than email,” “it’s [a] good way of reducing email number,” and “It’s like [a] professional whats app group”	
What did you NOT like about the Slack (or GroupMe) app (used to communicate instead of email)?	
Nothing	80
It was too public	1
It was annoying getting messages from everyone	7
It was difficult to use	3
It was difficult to follow what was being said	1
Other:	9
Other responses included “I forgot I needed to check messages on Slack,” “I was not getting important information that was posted to the general chat. However, I always got notifications from private messages,” “I never got notifications like I was supposed to and very nearly missed an assignment due to that,” “Setting it up was difficult,” “[yet] another app in phone,” and “sometimes it freezes”	

Twitter have also been observed (Adams et al., 2018; Gonzalez & Gadbury-Amyot, 2016) and, although this was not one of the responses offered in our survey, it was also not a write-in response.

The majority of students self-identified that participating in the Twitter assignment increased their knowledge of agricultural issues either significantly (49%) or slightly (32%) (Table 1). This is important as, according to one study, 65% of academics were using Twitter for academic purposes, but this was only the case for 28% of undergraduate students (Knight & Kaye, 2016). If students can identify with using Twitter for practical purposes, this may assist these students, particularly those at the graduate level, to be successful in this area. Other studies observed that students believed Twitter was good for learning and getting information, and this relates well with the results of this survey research (Evans, 2014; Menkhoff et al., 2015).

3.2 | Blogging

As with the Twitter assignment, the blogging assignment was found to provide a number of positive outcomes. Student comments included, “it’s the way of expressing knowledge and expression in a more professional way,” “let me rant

about what I was struggling with,” and “most importantly, it improves my generic writing skill other than paper.” The majority of students liked that it helped them to organize their thoughts (65%), improve their ability to communicate about agriculture (61%), made them think about their interests in agriculture (59%), and were able to write in a nontechnical way about agriculture (55%) (Table 2). Others have identified the potential for self-reflection within blogging (Deng & Yuen, 2011) and that they can be used to assist with writing, particularly with informal, or nontechnical, writing (Morris, Christie, & Barber, 2019), which was also found in our research. Students in other studies have also identified enjoying the informal writing that blogging provides (Sullivan & Longnecker, 2014).

The majority of students (58%) did not find anything they did not like about the blogging assignment (Table 2). One student comment, “figuring out how to share the blog without paying was difficult” was provided. Some concerns from the survey included that it was difficult to identify things to write about (19%), which has been identified by others (Farmer, Yue, & Brooks, 2008; Tekinarslan, 2008). Some students also did not like writing about themselves (17%) and/or were concerned about the public nature of the blog (16%). Although the majority of students in a study by Sullivan and Longnecker (2014) believed that knowing

TABLE 4 Clicker or PollEverywhere use in the classroom ($N = 69$)

What did you like about using clickers (or PollEverywhere) in class?	% of respondents
Nothing	0
They were simple and easy to use	59
They helped me to participate more than I normally would	54
They helped me to remember the information discussed in class	51
They made me more attentive in class	54
They made the class more interactive	57
Other:	3
Other responses included “it made learning interesting” and “I never used it but I was a distance learner. But if I had I think it would have helped me to remember stuff from class.”	
What did you NOT like about using clickers (or PollEverywhere) in class?	
Nothing	93
The clickers (or app) were difficult to use	0
The clickers (or app) were unreliable	1
The questions were too difficult	0
Other:	6
Other responses included “sometimes every clicker I chose would be dead,” “I couldn’t figure out how to look at questions and the correct answers later,” “signing on to use,” and “synchronicity with the class”	
By using clickers (or PollEverywhere), I believe my knowledge of the material:	
Increased significantly	58
Increased slightly	30
Remained the same	10
I did not use clickers (or PollEverywhere) in the classroom	1

other students (90%) and the general public (83%) could read the blog motivated them to write better posts, 10% believed their class blog should not be freely accessible on the internet.

Overall, 93% of students believed that blogging increased their communication skills (Table 2). This is similar to Sullivan and Longnecker (2014), where 95% of students believed that blogging helped them improve their writing skills. Others also identified increases in student communication skills with specific mention of these being transferable skills that can be used in their future careers (Morris et al., 2019). As there are many careers within agriculture where communication to the public is important, nurturing writing skills beyond simply technical writing would be a great advantage for the future of agriculture.

3.3 | Mobile communication technology

Overall, students believed that using a mobile app instead of email to communicate outside of class had a number of pos-

itive attributes including greater interaction with the instructor (84%), it was easier to use (64%), greater interaction with students in the class (51%) and it was more fun to use (43%) (Table 3). Positive student comments included, “it was faster to use than email,” “it’s a good way of reducing email number,” and “it’s like a professional WhatsApp group.” All negative reactions had low responses that ranged from 1 to 7% and negative student comments included “I forgot I needed to check messages on Slack,” “I was not getting important information that was posted to the general chat. However, I always got notifications from private messages,” “I never got notifications like I was supposed to and very nearly missed an assignment due to that,” “setting it up was difficult,” “another app in phone,” and “sometimes it freezes.” This mobile app was used in a way that was similar to social media by increasing interactions among the class outside of normal hours. Though, to our knowledge, no research has been performed to identify how these types of apps enhance engagement, social media has been found to provide positive engagement between students and between students and instructors (Arslan, 2018). The instructor for this course advised students that the best

TABLE 5 Video production assignment results ($N = 39$)

What did you like about the video project assignment?	% of respondents
Nothing	3
I was able to be creative	54
It made me think about the method in greater detail	54
It improved my ability to communicate through a different medium	77
Having the video uploaded to YouTube	13
Sharing the video I made with others	23
Other:	3
Other responses included “Most importantly, it creates impetus to produce more videos in [the] future”	
What did you NOT like about the video project assignment?	
Nothing	59
It was too difficult	0
The video editing software	26
Sharing the video with others through YouTube	10
Sharing the video with others in the class	5
It did not improve my communication skills	3
Other:	5
Other responses included “given time was too low to present a method” and “time constraint. Hard to thoroughly explain a method in that time.”	
By participating in the video project assignment, I believe my communication skills:	
Increased significantly	36
Increased slightly	54
Remained the same	10
I did not participate in the video project assignment	0

way to communicate outside of normal business hours was by using the mobile app, which again is related to social media where it could be used to extend class time (Chawinga, 2017). Menkhoff et al. (2015) observed that 93% of student respondents felt that Twitter increased student interactions with each other and 54% felt it was a good way of communicating with the instructor. Although this is opposite the results of the current study, it was likely because the main use for the mobile app was communication with the instructor; however, private messaging between students was possible. Also, the Menkhoff et al. (2015) study focused on live communications during class time.

3.4 | Classroom response systems

Positive responses to the use of clickers or the PollEverywhere app ranged from 51 to 59% (Table 4). The positive student comments included, “it made learning interesting” and “I never used it, but I was a distance learner. But if I

had I think it would have helped me to remember stuff from class.” These systems have been identified as beneficial for increasing attention and knowledge construction and providing interaction and engagement (Wu et al., 2019), which were all part of the positive responses observed in this study. Others have identified the anonymity provided by these systems (Raes et al., 2015), which may have been why 54% of students in the current study liked the systems because they “helped me to participate more than I normally would.” Some of the negative challenges of these systems have been identified by others and include technology-, teacher-, and student-related challenges (Kay & LeSage, 2009). There were 93% of students in the current study who identified no issues with the clickers or app that were used in the classroom; however, a few comments reflected technology-related issues. Negative student comments included, “Sometimes every clicker I chose would be dead,” “I couldn’t figure out how to look at questions and the correct answers later,” “signing on to use,” and “synchronicity with the class.” Overall, 88% of students believed the classroom response systems helped them to increase their

knowledge of the material either significantly (58%) or slightly (30%). Students have self-identified increases in their learning when using these systems before (Wu et al., 2019); however, one study observed that, when comparing classes that used or did not use these systems, final course grades were significantly different with students in classes using clickers having 4.7% higher final course grades (Bojinova & Oigara, 2013).

3.5 | Video production

The specific positive attributes of the video production assignment ranged from 13 to 77% (Table 5). A single positive student comment was “Most importantly, it creates impetus to produce more videos in future.” The greatest positive response from students was that the video production assignment improved their ability to communicate through a different medium (77%). This is similar to research by Willmot, Bramhall, and Radley (2011), who found that about 80% of engineering students liked creating an explanatory/documentary video and felt that it increased their researching, communication, and IT skills. Others have found that incorporating video production in the classroom can provide or enhance learning through positive emotions (Pirhonen & Rasi, 2017). The current study found that students also liked the assignment because it made them think about the method in greater detail (54%) and/or allowed them to be creative (54%), which relates well to these previous findings. Some students also liked that the videos were shared with others (23%) and/or were uploaded to YouTube (13%). In research by Pirhonen and Rasi (2017), students felt motivated because the video they were creating would be used in the future, which may be related to this response data. Negative student comments included “given time was too low to present a method” and “time constraint, hard to thoroughly explain a method in that time.” The major negative aspect of the assignment was focused on the video editing software that received responses by 26% of the students. Two different free options were provided, both of which had been used previously by the instructor, but it may be that neither of these were user friendly enough or the initial learning curve for engaging in video editing was high. Sharing the video via YouTube (10%) and with others in the class (5%) also had negative responses from students but were lower than the number of positive responses for these same categories. Similarly, Pirhonen and Rasi (2017) observed greater positive emotions than negative ones for their video assignment. Overall, 90% of students believed that their communication skills increased (36% significantly, 54% slightly) as a result of completing the video assignment. Similarly, 60% of students using a video blog as part of an oral training course indicated an increase in their presentation skills (Liu, 2016).

4 | CONCLUSIONS

Incorporating technology in the classroom is important for enhancing communication between students and instructors and to allow these tools, which are readily available to students, to be applied in an academic setting and for a professional purpose. If higher education institutions are unable to become adopters, it could hinder their teaching capacity and increase the divide between them and the public. Using technology, however, must be done in an authentic way and with a purpose that is easily realized by the student. Therefore, research that focuses on ways to use these tools in the classroom and student perceptions of these tools is a priority. In this research, five different types of applications were used in a graduate-level classroom to assess their potential for increasing student communication skills or knowledge and identify their respective advantages and disadvantages. The majority of students across six semesters identified positive results for all five of the imposed interactions. Therefore, the recommendation to educators is to apply these different technologies within courses where they can enhance the environment and student learning potential. Though this was applied to agriculture majors, they can likely be applied within many areas of the natural and physical sciences and beyond. For instance, instead of following an agriculture-related Twitter discussion, students could be assigned to participate in a different, discipline-specific online discussion. If one does not exist, it could be created by the instructor for the classroom using a course-specific hashtag or by using an online communication tool like Slack or GroupMe. Anecdotally, the majority of students seemed to enjoy engaging in these kinds of discussions. Many remarked surprise at being able to engage in thoughtful, well-behaved discussions on a platform like Twitter. Based on comments from homework assignments that were turned in as part of the Twitter assignment, most students also found these discussions to be interesting or helpful. They enjoyed getting the perspectives of other people.

These technologies can also be particularly useful in light of the recent events surrounding the COVID-19 pandemic, which caused most institutions to cancel on-ground courses and move to online ones. The results from the Spring 2020 semester were also included in this study and, aside from slight modifications in grading and viewing for the digital video assignment, the course continued seamlessly online. Utilizing multiple forms of easily accessible technology, such as those outlined in this study, therefore, can assist instructors in implementing courses that have greater resilience and can still provide effective communication and learning opportunities for students. Though there were few specific differences in results identified for the Spring 2020 semester as compared with other semesters, these technologies can help provide more of a community/classroom feeling than

a typical online course delivery module would in a number of ways:

- Though, in our study, the PollEverywhere app was no longer used once the course moved to online only in Spring 2020 (the existing course schedule involved activities other than lecture), using the PollEverywhere app would allow students who were not on campus to answer questions via their smartphone. This would occur in the same way they would use handheld clickers in an in-person course and see the results in real-time with their classmates as part of the online lecture. These are useful not only in assisting with retention of material or identifying student needs but can also help break up an online lecture.
- Students can engage with other classmates or the instructor using either Twitter or Slack/GroupMe apps. Emailing may be perceived as a more formal type of communication where the apps provide for a more casual atmosphere. It seems much easier to engage in conversational discussions with students due to the greater use and allowance of things like emojis and images that these apps provide.
- Incorporating blogging, particularly a classroom blog where the students are able to self-publish as authors, may help enhance a community feeling as the students are all building something they can be proud of and others can see. Requiring students to comment on other students' posts is also helpful because it incentivizes greater dialogue and allows students to learn more about their classmates. In Fall 2020, required posts were focused more on personal essays related to the student's own experiences in agriculture rather than on descriptions of specific agricultural topics to enhance this community building approach. This has likely allowed students and the instructor to learn more about all of the students in the classroom than any in-person format of this course has before.
- Incorporating video development/production into a course can help provide a creative outlet to students, particularly when few are available. With a video production activity, it will be important to be mindful about length requirements as some students in this exercise felt the length (1–2 minutes) was too short. This must be weighed against realistic viewership time for most YouTube videos. The few observed differences between Spring 2020 and other semesters came from the creativity involved in this activity identified by 73% of respondents as compared with 40 and 54% of respondents from previous semesters. Also, students liked sharing the video more with others (45%) than in previous semesters (13 or 15%), which may have been part of establishing a community that was previously mentioned. Although our University had moved from on-ground to online about 1 week before this assignment was due, the survey results were collected about 7 weeks into

self-isolation. Either the rapid change away from in-class activities or the reflection after a longer period in isolation may have resulted in this difference for the Spring 2020 semester.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

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