AN EXAMINATION OF UNDERGRADUATE STUDENTS' PERCEPTIONS OF TECHNOLOGY USE IN ONLINE LEARNING

A Dissertation

by

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ABSTRACT

Online learning, also known as e-Learning, allows individuals the flexibility to access interactive learning environments to gain knowledge, skills, and abilities for both personal and professional purposes. The use of technology within these environments has the potential to influence students' perceptions of satisfaction, quality and learning. The purpose of this quantitative study was to examine perceptions of undergraduate students majoring in the College of Agriculture and Life Sciences at Texas A&M University regarding technology use to enhance interactions in online learning environments. Based on transactional distance theory, this study focused on the relationship between technology use, four types of interactions, and learners' attitudes toward satisfaction with, perceived quality of, and perception of learning increases during an online learning experience. An online questionnaire was used for data collection and a total of 362 undergraduate students participated in the study. Descriptive analyses, exploratory factor analysis, logistical regression analyses, and independent-samples t-test analyses were utilized to analyze the data.

Study participants tended to agree that using certain technologies in online courses could increase learner-to-learner interaction (i.e., collaborative documents, instant messaging, and social media), learner-to-instructor interaction (i.e., lecture, email, and online editing and feedback), learner-to-course content interaction (i.e., PowerPoint, online practice exercise, and collaborative documents), and learner-to-course technology interaction (i.e., search engines, file management systems, and online

tutorials). Participants also tended to perceive greater satisfaction, quality, and learning increase within an online learning experience when instructors provided opportunities for all four types of interaction.

The results showed that different types of technology may have different levels of influence on students in regards to enhancing interactions with other learners, with the instructor, with course content, and with course technology in online learning environments. Different types of interaction also may influence students' attitudes toward their satisfaction with online learning experiences, the quality of online learning experiences, and increased learning in online learning environments. Based on the finding that using specific technologies in an online course may improve interactions, instructors should strive to provide these opportunities. These findings support previous research and support expanding the use of technology to enhance interactions.

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CHAPTER I

INTRODUCTION

With the development and continued improvement of the Internet, mobile devices, and multimedia technology, people have much greater acceptance of using technology and online learning opportunities to obtain knowledge and professional skills (Reeves, 2009). Taking classes online is no longer new or unique.

Online learning, also known as e-Learning, is an innovative method that allows anyone the flexibility to access well-designed, learner-centered, and interactive learning environments with digital multimedia technology that assists both learning and teaching anytime and anywhere through the Internet, networked computers, or mobile devices (Awadh & Higgins, 2013; Teo, 2014). Unlike traditional face-to-face classes, students in an online class can learn course content through the Internet without location and time limitations. Students are free to access learning materials and instruction anywhere and anytime with Internet access. This type of learning format makes learning more flexible, as online learners also have the freedom to control their learning path in the online class (Al-Musa & Al-Mobark, 2005; Wang, 2007).

Research has shown that the learner's personality plays an important role in their performance and achievements in online courses (Keller & Karau, 2013). Unlike in a face-to-face course setting, instructors and learners are physically separated in online classes. Successful online learners need to be self-directed with strong motivations to gain knowledge independently in the online learning environment (Mueller, Wood,

Pasquale, & Cruikshank, 2012). Online learners also need to able to effectively manage their time for learning (Paechter, Maier, & Macher, 2010). In summary, some general characteristics of online learners who are successful in online learning include being self-disciplined, motivated, goal-oriented, able to manage time, comfortable using multiple types of technology, able to communicate, and able to interact (Dabbagh, 2007; Song, Singleton, Hill, & Koh, 2004).

Some students have reported that they feel isolated from both other students and the instructor while participating in online courses (Song et al., 2004). Lack of adequate interaction with others is one of the barriers to students reaching success in their online class. Davies and Graff (2005) found that students who failed in their online classes tended to have fewer overall interactions. Song et al. (2004) also mentioned that high-quality online class design and the use of effective technologies are important factors that enhance students' performance and learning outcomes in the online classes. It is mandatory for instructors to actively facilitate adequate interactions with and among students in their online course design.

Using effective multimedia technology is a valuable strategy to enhance interactions in an online class setting (Hooper & Rieber, 1995). Today, instructors can choose from a great variety of instructional and teaching technologies. Mobile devices, multimedia software, presentation software, mobile application software, communication tools, audio/video tools, social media, and document sharing and management systems are popular examples currently being used in education (Beldarrain, 2006; Hiltz & Turoff, 2005; McGreal, 2004). However, not all types of

technology are beneficial to students engaging in online learning. A diverse group of students may have different interaction engagement levels and abilities to use technologies in online learning (Wang, 2007). For example, students from different countries or backgrounds may have different experiences with participation in online classes and using technology to assist their learning (Hammer, Janson, & Leimeister, 2014).

The influences of each technology type on students' learning and interactions may be different in online classes compared to face-to-face courses. Some variables, such as class types, topics, or presentation methods, may also influence the choice of technology used in the online class. Lindner, Rodriguez, Strong, Jones, and Layfield (2016) stated that evaluation of the validity of educational technologies is required to improve the teaching and learning process in the classroom. The ability of instructors to select effective technology and appropriately design online courses to improve interactions is vital to online learning (Dooley, Lindner, & Dooley, 2005).

Selecting technologies that are the most appropriate for an online class and will enhance students' learning is a challenge for instructors. Economic and technical advantages are the main influencers on instructors' technology selections for course instruction (Soo & Bonk, 1998; Su, Bonk, Magjuka, Liu, & Lee, 2005). Most instructors may simply select the technology that they are most familiar with or that is low cost as tools for their courses (Soo & Bonk, 1998).

Ability to use technology and change deep-rooted habits in teaching are two challenges that instructors face when selecting technologies to enhance interaction and

reach their desired levels of instructions in online class, but instructors' abilities to use technologies are unique and varied. Stenhoff, Menlove, Davey, and Alexander (2001) pointed out that instructors' unfamiliarity with technology is one of the key reasons that technologies are not utilized to enhance online interactions. Additionally, some instructors have time limitations on learning and practicing specific technology for use in the online class (Su et al., 2005). For this reason, most instructors will use the technologies they are familiar with instead of selecting new and more effective technology for their online courses.

For some instructors, especially those familiar with teaching face-to-face classes, longstanding teaching habits may also influence their course design and technology selections for the online class. However, the learning environment and interactions of a traditional class differ from online classes. When instructional methods shift from the traditional class to the online learning environment, instructors may face challenges and difficulties transforming their past instructional skills and previous teaching experiences (Stenhoff et al, 2001).

Statement of Problem

Moore's (1989) transactional distance theory revealed four main types of interactions that have significant influences on students in an online course or other asynchronous learning environment in which learning occurs at the student's chosen pace. According to this theory, dialogue, structure, and learner autonomy are three crucial variables that impact the degrees of transactional distance to students in online

courses. Four types of interactions, including learner-to-learner interaction, learner-to-instructor interaction, learner-to-course content interaction, and learner-to-course technology interaction, have different levels of influence on learners' satisfaction and attitudes toward learning increase in and the quality of the online course.

Several studies have shown that technology is a powerful resource to improve students' online learning performance (Banna, Lin, Stwart, & Fialkowski, 2015; Hiltz & Turoff, 2005; Ng, 2007; Vonderwell & Zachariah, 2005). Some of these studies have also pointed out that using different types of technology in an online course may benefit students by strengthening each type of interaction in online learning environments (Chang, 2013; Hiltz & Turoff, 2005; Jung et al., 2002; Seidel, 2012). However, there is no systematic study that focuses on the effectiveness of each specific technology to enhance unique types of interactions in online courses and explores students' perceptions toward online learning and technology use.

To explore and determine students' attitudes toward the effectiveness of technology on enhancing interactions in online agriculture-related courses, an examination of agricultural students' attitudes toward online courses and technology use to enhance interactions in online courses was conducted with students majoring in the College of Agriculture and Life Sciences at Texas A&M University.

Purpose of Study

The purpose of this quantitative study was to examine and identify undergraduate students' perceptions of technology use to enhance interactions in online learning environments. Undergraduate students who were majoring in the College of Agriculture and Life Sciences at Texas A&M University were the target population for this study.

Research Questions

This study sought to answer the following research questions:

1. What are agricultural undergraduate students' attitudes toward technology use for enhancing interactions in the online learning environment?
2. What types of technology could be significant predictors for students' perceptions of satisfaction with and quality of the online learning experience and for learning increase in an online course?
3. Do personal characteristics impact agricultural undergraduate students' perceptions of technology use for enhancing interactions in an online learning environment?

Theoretical Framework

The theoretical framework used in this study was adapted from Moore's (1989) transactional distance theory. Moore (1989) stated that "the whole point and purpose of distance education theory is to summarize the different relationships and strength of relationship among and between these variables that make up transactional distance, especially the behaviors of teachers and learners" (p. 23). Transactional distance theory

reveals relationships between learner-to-learner interaction, learner-to-instructor interaction, learner-to-course content interaction, and learner-to-course technology interaction in the online course and some asynchronous learning environments (Moore, 1989).

The term transactional distance refers to the concept that distance between learners and instructors, in an online setting, is not just geographic but is also impacted by psychological and communicational characteristics that can cause mental separation from each other (Bentley & Dewey, 1949; Boyd & Apps, 1980). Moore (1989) also mentioned that dialogue, structure, and learner autonomy are three crucial variables that impact the degrees of transactional distance a learner experiences.

Dialogue, Structure, and Learner Autonomy

Dialogue is defined as interactions and communications that occur between students and the instructor during a class but can also be thought of as the exchanges of words, actions, and ideas (Kang & Gyorke, 2008). Moore (1989) stated that there are several elements that may have some impact on effective and quality dialogues including instructors' personality, learners' personality, course content, and use of technology to participate in conversations. When instructors provide more high-quality dialogue in the online class, students feel less transactional distance (Moore, 1989). On the other hand, in an online class with less dialogue, students may feel more transactional distance. Hence, quality and amount of dialogue impacts students in an online course.

Structure is generally understood to mean the measurement of rigidity or flexibility of some class components such as learning objectives, content themes, presentation strategies, and evaluation activities that are utilized to meet each learner's needs in a course (Kang & Gyorke, 2008; Moore, 1983). A high level of structure is not beneficial for students as they may interpret this as strictness and find adapting to the class difficult. Furthermore, extreme structure can be interpreted as a course being too difficult and can cause learners to feel an increase in transactional distance (Moore, 1989).

Learner autonomy refers to the learner's ability to control learning activities and the learning process (Knowles, Holton, & Swanson, 2005). In an online class, students must be self-directed learners. Because there are no regular class hours or fixed physical classroom in the online course, students must have the ability to create a learning plan to track their learning progress. If students lose control of this self-directed learning, they may easily give up on learning or experience lower performance in the online class (Knowles et al., 2005). In addition, when greater transactional distance exists in an online class, learners report greater learner autonomy and must exhibit more self-directed learning to be successful in the online learning environment.

Students may have different levels of learner autonomy. According to the staged self-directed learning model (SSDL), Grow (1991) stated that the ability to be a self-directed learner is situational. For example, a student may be a self-directed learner in math but a dependent learner in language. Therefore, the learning topic is one factor that may influence a student's ability to be a self-directed learner. In addition, Grow (1991)

proposed that there are four student styles and four matching teacher styles in the SSDL model. Students may experience four stages in their journey to becoming a self-directed learner, including dependence, interest, involvement, and self-directedness. For each stage, the instructors also play different roles including authority, motivator, facilitator, and consultant and modify their instructions or teaching strategies to assist students in becoming a self-directed learner.

For each online class or program, the levels of dialogue, structure, and learner autonomy can be unique. According to the transactional distance theory, instructors should place greater emphasis on dialogue and structure for their online class design (Moore, 1989). In addition, based on the average of students' learner autonomy levels, instructors can provide corresponding ratios of dialogue and structure in their online class to reduce the transactional distance to students. Then, students may have a higher possibility to reach success in online learning (Moore, 1983; Moore & Kearsley, 1996).

Four Types of Interactions in Online Learning

According to Moore's (1989) transactional distance theory, there are only three types of interactions that may influence students' performance in online learning; these include learner-to-learner interaction, learner-to-instructor interaction, and learner-to-course content interaction. Learner-to-learner interaction refers to the amount of interactions such as conversations, discussions, and information sharing among students. Learner-to-instructor interaction refers to the interactions between learners and the instructor in an online class. Learner-to-course content interaction is defined as learners'

understanding and perspective of knowledge through interaction with course content or instructional materials. Hillman, Wills, and Gunawardena (1994) stated that learner-to-course technology interaction should be added to Moore's transactional distance theory due to rapid progress in technology and mobile devices. Learner-to-technology interaction allows both instructors and students to realize how technologies enhance learners' learning outcomes and performance in an online class (Dooley et al., 2005). If students cannot sufficiently interact with the technology utilized in an online class, they may face more challenges in reaching success in that course or program.

According to the transactional distance theory, not only are the variables of dialogue, structure, and learner autonomy present, but planning for four types of interactions is crucial in the online class design to reduce the influences of transactional distance to students. Moore and Kearsley (1996) found that students who have high-quality interactions in the online class feel less transactional distance. Using transactional distance theory as the framework, we can explore how to utilize the relationship between technology, interactions, and transactional distance to enhance students' learning in the online class. We can also examine what types of technologies are effective tools to enhance student learning in online environments.

Research Objectives

The objectives were based upon Moore's (1989) transactional distance theory and were as follows:

1. Identify and describe student perceptions of specific technology use to enhance learner-to-learner interaction for online learning.
2. Identify and describe student perceptions of specific technology use to enhance learner-to-instructor interactions for online learning.
3. Identify and describe student perceptions of specific technology use to enhance learner-to-course content interactions for online learning.
4. Identify and describe student perceptions of specific technology use to enhance learner-to-course technology interactions for online learning.
5. Identify and describe students' satisfaction, perception of quality, and perception of learning increase when interactions are provided during an online learning experience.
6. Explore and describe which technologies in an online learning environment can be a significant predictor of students' satisfaction, perceived quality, and perception of learning increase when interactions are provided during an online learning experience.
7. Determine and describe students' preferences for technologies used to enhance interactions for online learning.
8. Examine the relationship between students' selected personal characteristics and preference for technologies to enhance interactions in online learning.

9. Examine the relationship between students' selected personal characteristics and students' satisfaction, perceived quality, and perception of learning increase when interactions are provided during an online learning experience.

Significance of Study

Examining students' attitudes toward technology use and relationships among interactions in the online class may have practical and academic implications. This study aims to contribute to the educational field using detailed quantitative data to reveal the effectiveness of each technology for enhancing the four types of interactions in online learning from the student perspective.

The results provide a guide for instructors of online courses in regard to technology use. The examination of the relationship between appropriate technology and enhancing interactions provides input for course delivery decisions. The significance of this study relates to the establishment of a resource for instructors who desire to establish online learning systems and must select technology for their online courses. Online learners can benefit from this study through a better understanding of technology selection and use in order to overcome interaction barriers and enhance their learning performance in online learning environments.

The results of this study also support the concepts of Moore's (1989) transactional distance theory regarding the relationship between interactions and technology use in the online courses to effectively enhance learners' perceptions of satisfaction, quality, and learning in online learning environments.

Definitions of Terms

E-Learning: An innovative method that allows anyone a flexible way to access and utilize well-designed, learner-centered, and interactive learning environments through the Internet, networked computers, mobile devices, or multimedia technology for learning and teaching at any time or place (Awadh & Higgins, 2013; Teo, 2014).

Learner-to-learner interactions: "Type of interaction that occurs between one learner and another learner, alone or in group settings, with or without the real-time presence of an instructor such as online-chats, threaded discussion, e-mail, point-to-point video conference, and audio calls" (Dooley, Lindner, & Dooley, 2005, p. 285).

Learner-to-course content interactions: "Process of interacting with content to affect the learner's understanding, perspective, or cognitive structures such as online books, online instructional materials, support materials, worksheets, and case studies" (Dooley et al., 2005, p. 284).

Learner-to-course technology interactions: "Examples of learner-to-technology interactions include online tutorials on how to use educational technology, getting help online, downloading plug-ins, installing software, file management including uploading and downloading files, and electronic libraries" (Dooley et al., 2005, p. 285).

Learner-to-instructor interactions: "Student-teacher interactions undertaken to attempt to motivate and stimulate the learner and to allow for the clarification of misunderstandings by the learner in regard to the content such as lecture, e-mail, online editing and feed-back, evaluation of learning, ITV, streaming video, and voice over Power Points" (Dooley et al., 2005, p. 285).

Technology: This term is used to represent all types of instructional tools that allow students to access and interact with learning materials, instructors, and fellow students including software, computers, mobile devices, and the Internet (Beldarrain, 2006; Hiltz & Turoff, 2005; McGreal, 2004).

Assumptions

1. Respondents completed the instrument honestly and to the best of their ability.
2. The data and analysis of the data reflected the respondents' answers accurately.

CHAPTER II

REVIEW OF LITERATURE

Students' attitudes toward technology use to enhance interactions in online learning can directly impact learning and engagement. The purpose of this chapter was to provide a review of literature related to the use of technology to enhance interactions in online courses. The literature is presented as five major themes: (a) features of online learning, (b) interactions within the online classroom, (c) satisfaction, quality, and learning, (d) technology use in online courses, (e) commonly used instructional tools in online classes, and (f) characteristics of students as related to online courses.

Features of Online Learning

Many people rely on the convenience of mobile devices and "apps" in today's daily life. Computers, mobile devices, and the Internet have changed the lifestyles of modern society. Personal computers and mobile devices are commonly used for a multitude of activities, including formal education, entertainment, or informal searching for information. Increasing numbers of people are also willing to participate in online learning in recent years (Beldarrain, 2006: Kim & Bonk; 2006). Online learning is an innovative course delivery method that is widely accepted by most higher education institutions (Awadh & Higgins, 2013).

Online learning has benefits and advantages for different types of learners (Awadh & Higgins, 2013). For students, online learning provides more opportunities and

flexibility for learning or continuing students' education without time, place, and age limitations. People, regardless of geographic location, can access diverse learning resources through the Internet without leaving home (Awadh & Higgins, 2013; Chen & Huang, 2010). From the higher education institution's perspective, online learning can address geographical and even political restrictions and provide efficient and economical choices to a larger group of learners. Some universities can utilize online classes to share learning resources among institutions while others can use online learning to meet the needs of learners who are far from educational institutions (Awadh & Higgins, 2013; Chen & Tseng, 2012).

Unlike traditional face-to-face classes, online classes require different teaching and learning methods. Students and instructors may experience conflict due to the sometimes dramatic changes in methodology needed when switching from a traditional learning format to an online learning format (Teoh, Bhati, Lundberg, & Carter, 2013). Due to usage of multimedia technology, learning alone, and the presence of multiple types of interactions in the online course, both learners and instructors must commit time and resources towards adoption of this new, creative learning method (Akkoyunlu & Soylu, 2006; Hameed, Badii, & Cullen, 2008).

Webster and Hackley (1997) asserted that learners' performance, participation, technology self-efficacy, and cognitive engagement in online learning can serve as important indicators of the effectiveness of an online course. Volery and Lord (2000) revealed that technology, instructor characteristics, and student characteristics are three main factors that can influence the effectiveness of online learning. Convenient access,

perceived richness of information provided by technology, teaching styles, the ability to use technology, instructors' attitudes toward technology, learner gender, and previous online experiences are additional but less impactful factors which may influence the effectiveness of online learning. Similarly, Song et al. (2004) pointed out that course design and learners' motivation, time management, and comfort with online technology are vital elements to have in place for learners to be successful in online learning.

Social interaction, administrative or instructor issues, learner motivation, time management, and study support are identified barriers related to students being able to learn successfully in online classes (Volery & Lord, 2000; Lin & Berge, 2005). Lack of social interaction has been shown to be the most important barrier to learning in online classes (Lin & Berge, 2005; Song et al., 2004). Given that learners and instructors are separated in the online learning environment, effective interaction requires special consideration. Learners who are new to the online environment face challenges associated with learning styles and learning methods due to courses' delivery method. The ability to be self-directed is a characteristic that is needed for learners to take full advantage of online learning resources (Volery & Lord, 2000).

Interactions within the Online Classroom

The importance of interactions in a high-quality online class has been investigated by several researchers. The promotion of meaningful and productive interactions is an important focus of effective and successful online class design (Beuchot & Bullen, 2005; Su et al., 2005). Interactions are a crucial factor that enhances

students' learning performance and satisfaction in online courses (Jung, Choi, Lim, & Leem, 2002). Moore (1993) mentioned that increasing interactions between the instructor and students in the online class can effectively decrease transactional distance and result in higher quality learning.

High-quality interactions in online learning environments not only provide more opportunities to be a self-directed learner but also increase students' online participation and engagement in learning activities and discussions (Karayan & Crowe, 1997; Ni, 2013; Smith & Hardaker, 2000). Davies and Graff (2005) stated that students who have fewer communications and interactions with others during online learning are more likely to demonstrate lower performance in online learning. Yang, Olesova, and Richardson (2010) also pointed out that students who receive higher quality interactions in an online course will perform and learn at a higher level than others. Therefore, allocating more attention to learners' interactions is vital.

There are multiple categories of interactions that can be measured in an online learning class. First, synchronous interaction and asynchronous interaction are two kinds of interactions that relate to the time that interaction occurs. Depending on the context of the interaction, personal interaction and social interaction are two additional examples. Anderson (2008) mentioned that learner-to-learner, learner-to-teacher, learner-to-content, teacher-to-teacher, teacher-to-content, and content-to-content are four types of interactions in the online courses. Further, Bates (1995) mentioned that diverse learning objectives need different kinds of social interactions to help learners reach success in online learning environments.

Three specific types of interactions, including academic interaction, collaborative interaction, and social interaction, are generally used to predict or measure students' learning, satisfaction, and attitudes toward online learning (Jung et al., 2002). Academic interaction includes interaction between learners and online resources as well as task-oriented interactions between learners and the instructor. Collaborative interaction is a type of interaction among learners that takes place when a group of learners work collaboratively on a specific topic or share ideas and materials to solve a given problem. Social interaction is defined as the interaction between learners and instructors that occurs when instructors adopt strategies to promote interpersonal encouragement or social integration (Jung et al., 2002).

According to the transactional distance theory, three types of interactions are important to influence students' satisfaction, learning, and engagements in an online class: learner-to-learner interaction, learner-to-instructor interaction, and learner-to-content interaction (Moore, 1993). First, learner-to-learner interaction refers to the influence of communication tools, sharing documents, and discussions between learners on students' learning outcomes and performance. Second, learner-to-instructor interaction focuses on improvement of interaction between learners and the instructor by using technology such as video, audio/phone calls, and/or email. Third, learner-to-content interaction identifies types of learning materials and content that are more attractive to learners in online learning. Hillman et al. (1994) mentioned that learner-to-technology interaction is also an important type of interaction that can enhance students' performance and satisfaction in online learning. Learner-to-technology interaction

focuses on how technology can assist students in online learning. The transactional distance theory, as it relates to online learning, addresses all four types of interactions: learner-to-learner, learner-to instructor, learner-to-course content, and learner-to-course technology.

Vicarious Interaction and Maximized Learning

Dooley et al. (2005) believed that students could receive maximum satisfaction in an online class when all four interactions overlapped based on the transactional distance theory (Hillman et al., 1994; Moore, 1993). According to Figure 1, the area of overlap between the four circles is where vicarious learning occurs. In addition, the authors believed that the four types of interactions were equally important and have the same impact on students' satisfaction with an online class and their online learning outcomes. However, many researchers revealed that different types of interactions may have unique levels of impacts on students' attitudes toward online class satisfaction, quality, and learning (Chang, 2013; Jung et al., 2002; Kuo, 2014; Strachota, 2003; Seidel, 2012).

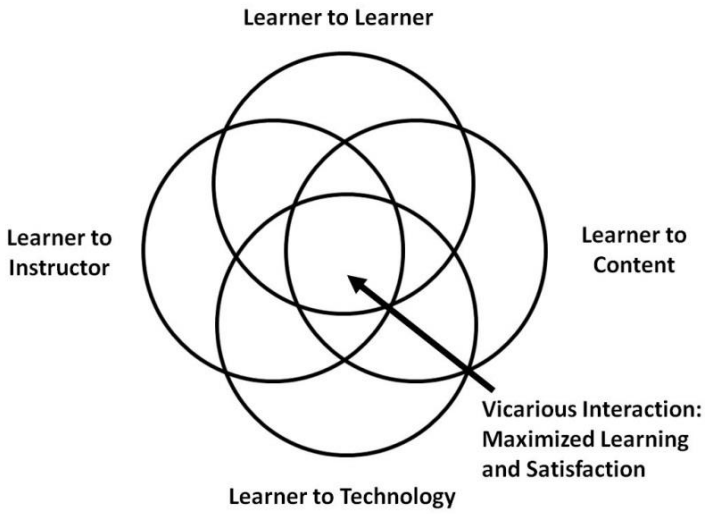

Figure 1. Depiction of vicarious interaction and maximized learning and satisfaction resulting from four learner relationships (Recreated based on Moore (1993) and Dooley et al. (2005)).

Satisfaction, Quality, and Learning

Satisfaction

Gunawardena, Linder-VanBerschot, LaPointe, and Rao (2010) pointed out that students who are actively participating in online class activities, interacting with others, and taking online courses constantly (i.e., higher levels of experience with online courses) have higher levels of satisfaction with online learning experiences than others. Learners' past experiences with technology and technology self-efficacy are also important components affecting learners' attitudes toward satisfaction in online learning environments (Gunawardena et al., 2010; Song et al., 2004). Because the learner's ability to use technology in an online course may influence their levels of receiving and accepting course content and learning materials, learners who have fewer technical

issues in online learning tend to have higher satisfaction than those with more technical issues (Teo, 2014).

Jung et al. (2002) revealed that interpersonal or social interactions like learner-to-learner interactions and learner-to-instructor interactions may also influence learners' satisfaction with online learning experiences. However, Strachota (2003) found that learner-to-course content interaction was the most important predictor of students' satisfaction in distance learning, and learner-to-instructor interaction and learner-to-technology interaction were secondary and tertiary, respectively, in importance in predicting students' satisfaction in the online classroom. Seidel (2012) and Chang's (2013) studies agreed that learner-to-course content was the most significant factor in predicting students' satisfaction in online learning. To summarize, the frequency of interactions in the online courses needs to be considered to enhance learners' satisfaction in online learning. According to previous studies, students who have more learner-to-course content interactions during online learning tend to be more satisfied with the online courses (Chang, 2013; Seidel, 2012; Strachota, 2003).

Quality

Lim and Morris (2009) identified several items that decrease the willingness of students to choose online learning and students' perceptions of quality with online learning experiences, including lack of human interaction, issues with technology use, delayed feedback, learning alone, and lower motivation for reading online materials. Sims, Dobbs, and Hand (2002) suggested that instructors could improve the quality of

the online learning experiences for learners by placing more emphasis on factors such as strategic intent, content, learning design, interface design, interactivity, assessment, student support, utility of content, and outcomes of online courses.

For learners' attitudes toward the quality of online learning experiences, learner-to-instructor and learner-to-learner interactions are the main influencing factors (Su et al., 2005). Similarly, Seidel (2012) found that learner-to-learner interaction best predicts students' attitudes toward the quality of the online class. However, Chang (2013) found that both learner-to-course content interaction and learner-to-instructor interaction were crucial factors to predict students' attitudes toward the quality of the online class. Based on these studies, either learner-to-instructor interaction, learner-to-learner interaction, or learner-to-course content interaction may have potential to influence students' attitudes toward the quality of online learning experiences.

Learning

Learners who were highly motivated and confident in online learning environments had a higher tendency to gain more from online learning than those with less motivation (Lim & Morris, 2009). Online course design, comfort with online technologies, and time management are three important characteristics of students learning well in online courses (Song et al., 2004).

Jung et al. (2002) found that learner-to-instructor interaction and learner-to-learner interaction were more likely to improve students' learning performance and increase participation in an online class than other types of interactions. Alternatively,

Seidel (2012) pointed out that learner-to-course content interaction was the main predictor for measuring students' learning in an online class. However, Chang (2013) found that learner-to-course technology interaction and learner-to-instructor interaction were significant predictors for measuring students' learning in an online course. In summary, all four types of interactions may have the potential to improve learners' performance and increase learning.

Technology Use in Online Courses

It is common to use multimedia technology as a delivery tool to present course content in online courses. Teo (2014) indicated that the technology used in the online course should be easily used but able to effectively assist students in online learning. Commonly used technologies in online courses include textbooks; multimedia that combines text, images, and audio through the Internet; and audio, video, and synchronous or asynchronous communication tools such as discussion boards, instant messaging, voice chatting, and file-sharing systems (McGreal, 2004).

Of the various tools used in online courses, Wang (2007) found that asynchronous tools such as discussion boards, email, listserv, and blogging, and synchronous tools such as live chat, webcast, instant messaging, video conferencing, and conference calls, are excellent technologies to utilize in online courses for most learners. Asynchronous tools are widely used in online learning environments and allow students more time to think thoroughly and prepare for written activities or presentations. Ni (2013) pointed out that online discussions can encourage some students who seldom

participate to join activities more often. Text-based tools allow these students to spend more time preparing and revising their questions or opinions before sharing them with other students in the class (McIsaac, Blocher, Mahes, & Vrasidas, 1999). Strachota (2003) found that students who are involved in discussions in the online course have much higher satisfaction than students who did not. Students may have better performance and feel more comfortable with online learning as a consequence of using asynchronous tools.

Based upon Moore's (1989) transactional distance theory, Dooley et al., (2005) identified types of technology that are useful for enhancing interactions in the online class, as shown in Table 1. Online chats, email, audio/phone calls, social media, interactive video conferencing, instant messaging, blogging, and collaborative documents are some examples of technologies that enhance learner-to-learner interaction. Technologies such as lectures, streaming video, email, voice-over PowerPoints, online editing and feedback, audio/phone calls, and evaluation were recommended to enhance learner-to-instructor interaction. Text/textbooks, online instructional materials worksheets, support materials, worksheets, case studies, PowerPoints, interactive video, online exercises, podcasting, and collaborative documents are examples of technologies to enhance learner-to-course content interaction. Finally, instructors can use technologies such as online tutorials, help modules, online instructions for downloading plugins, electronic libraries, software applications, file management systems, and search engines to improve learner-to-course technology interactions in online courses.

Table 1
Examples of Effective Technology to Enhance Interactions (Dooley et al., 2005)

Interactions	Examples of effective technology	
With other learners	▪ Online chats ▪ Email ▪ Audio/phone call ▪ Social sites	▪ Interactive video conferencing ▪ Instant messaging ▪ Blogging ▪ Collaborative documents
With the instructor	▪ Lecture ▪ Streaming video ▪ Email ▪ Voice over power points	▪ Online editing and feedback ▪ Audio/phone call ▪ Evaluation
With course content	▪ Text ▪ Online instructional ▪ Materials worksheets ▪ Support materials ▪ Worksheets	▪ Case studies ▪ PowerPoints ▪ Interactive video ▪ Online exercises ▪ Podcasting collaborative document
With course technology	▪ Online tutorials ▪ Getting help online ▪ Applications ▪ Electronic libraries ▪ Software	▪ A file management system ▪ Online instructions for downloading plugins ▪ Search engines

For most online courses, students do not have the opportunity to influence the choice of technology being used in the online course. Therefore, instructors need to ensure that students feel comfortable with using technology for learning and completing assignments (Vrasidas & McIsaac, 1999). Without this assurance, students may easily disengage from learning if they experience too many technical issues with the educational technology selected for their online course. If students refuse to use the available technology and fail to thoroughly engage in activities in the online course, their

performance may be lower than students who are fully engaged in online learning. According to Roger's diffusion of innovation theory (2003), instructors who modified their instruction to meet students' unmet needs were more likely to help students engage in the class and enhance the possibility of adopting new technology for learning.

Instructors cannot expect each student to be a master of utilizing different types of technology used in the online learning class (Teoh, Bhati, Lundberg, & Carter, 2013). Setting aside time at the beginning of the semester to teach and introduce technology that may be used in the online class is important, especially for technologies that could be new and unfamiliar to most students in the online class.

Song et al. (2004) found that learners' past experiences of technology use are a crucial factor that influences learners' attitudes toward the effectiveness of technology use in online courses. Students may be familiar with some media utilized in a course, but also may feel inadequately prepared for new technologies. Some challenges that students may face in an online course include a lack of technology skills and access and lack of instructor time and resources (Tham & Tham, 2013). Even though using different types of technology can support student engagement in the online course, a lack of abilities to use technology can be a strong barrier to learning. Instructors must fully understand students' abilities to use technology for online learning so that students can improve learning outcomes and performances (Tsai & Hwang, 2013).

Commonly Used Instructional Tools in Online Classes

For the purposes of this study, the term *technology* is used to represent all types of instructional tools that allow students to access and interact with learning materials, instructors, and fellow students including software, computers, mobile devices, and the Internet. Categories of technologies include communication tools, social interaction tools, document sharing and editing tools, visual and audio tools, and learning tools (Beldarrain, 2006; Hiltz & Turoff, 2005; McGreal, 2004).

Communication Tools

Email, audio/phone calls, instant messaging, threaded discussions, online editing and feedback, and evaluation are examples of communication tools. Email is the abbreviation of electronic mail, which allows people to exchange computer-based messages via the Internet. Audio/phone calls refers to using a telephone or app such as Skype, Viber, or Tango to have an oral conversation with others. Instant messaging allows people to send a short message to others via an app or Internet browser such as text, Whats App, Snapchat, Line, and Facebook Messenger. Although texts sent via mobile phones generally require money to send and receive messages, other types of instant message apps are free to utilize when linked to Wi-Fi or Internet. Threaded discussion is a type of discussion method used for talking and debating opinions via written responses in the online environment. Online discussion methods such as the threaded discussion allow students to have conversations in virtual environments without time and location limitations. Online editing and feedback is a system that allows the

instructor to edit and give feedback on student assignments or other documents. Evaluation (i.e., testing) is a systematic method to value a subject's worth and significance by using some standard or criteria. In the education field, this method is commonly used to evaluate knowledge gain.

Social Interaction Tools

Social media and blogs are two types of technology used for personal and professional social interactions online. Facebook, Instagram, LinkedIn, Google+, and Twitter are some currently popular types of social media. People can use social media to share personal information and interact with friends to make connections in online environments. WordPress, Pinterest, Blogger, and Tumblr are popular examples of blogging platforms, which can be used to share text with or without pictures with a wide audience.

Document Sharing and Editing Tools

Collaborative documents and file management systems are examples of document sharing and editing tools. Collaborative documents such as Google Docs or Quip allow a group of people to edit a document together via the online platform. File management systems allow people to manage and share documents with others in online systems; Dropbox and Google Drive are two examples of popular file management systems.

Visual and Audio Tools

Video, PowerPoint, voice-over PowerPoint, and podcasting are types of visual and audio technology tools. Video is an electronic medium for recording, copying, playback, broadcasting, and displaying moving visual media. People can utilize the YouTube website or app to search for instructional videos. PowerPoint uses slides to express concepts and ideas with pictures and text to learners. Microsoft PowerPoint and Prezi are two commonly used programs to create PowerPoint presentations. The term "voice-over PowerPoint" in this study means that voice recordings are added to each slide to explain information or concepts. Lastly, podcasting is a type of digital media file that contains a series of voice records; learners can listen to podcasts to gain information. There is a variety of podcast programs available on a diverse set of topics online.

Learning Tools

Lecture, textbooks, support materials, case studies, worksheets, online practice exercises, electronic libraries, and search engines are popular technologies that students often use for learning. Lecture refers to the instructor giving a talk or presentation about a topic, which could be either video or audio in online courses. Text/textbooks refers to documents or books which contain information and knowledge that are related to the course content. Support materials in this study refer to links or extended readings provided by the instructor to support course content. Case studies are reports or documents about a person or group of people, behaviors, issues, or situations that have been described in the literature and researched. Learners can investigate how to apply

theories, concepts, and skills to solve problems in existing examples from the case study. The worksheet is a type of learning document often used for classroom activities to increase student engagement. Online practice exercises, such as online quizzes, allow learners to check their understanding of the content and their learning performance through a list of questions. The electronic library is an electronic resource for searching and reading books, texts, articles, and papers online. Search engines such as Google, Bing, or Yahoo are online systems that are designed to search all information available online including texts, images, and videos.

Characteristics of Students as Related to Online Courses

In online learning environments, American students are learner-centered and peer-oriented (Yang et al., 2010). They tend to require two-way interaction rather than one-way interaction. American students are also more likely to interact with other students for learning. Liu et al. (2010) mentioned that American students enjoy using technology for online communications. For example, American students are more action-oriented and enjoy giving feedback to other students' posts during online discussions. They also prefer to use peer review or peer discussion as a method for learning. For online course assignment formats, American students pointed out that they are more likely to choose teamwork projects that allow students to learn and work together (Wang, 2007). Learner-to-learner interactions may be more important than other types of interactions for American students when learning online. Compared to

students from other countries, American students are more likely to be self-directed learners, learning materials by themselves in online courses (Liu et al., 2010).

According to the results of Seidel's (2012) study, there are positive relationships for American students learning in online courses between the use of effective technology and online interactions, including learner-to-learner interaction, learner-to-instructor interaction, learner-to-course content interaction, and learner-to-course technology interaction. Seidel (2012) found that American students believed that interactive video conferencing, online chats, and email were effective technologies; however, blogging was a less effective technology to enhance learner-to-learner interactions. Lecture, online editing and feedback, email, and voice over PowerPoint were reported as effective technologies, while evaluation (i.e., testing) was less effective in enhancing learner-to-instructor interactions in online courses. To enhance learner-to-course content interaction, support materials, online exercises, and online instructional materials were effective, and text was the least effective technology for American students. Electronic libraries, getting help online, and online tutorials were effective technologies, and file management systems and instructions for downloading plugins were less effective technologies to American students to enhance the learner-to-course technology interaction in the online learning environments (Seidel, 2012).

CHAPTER III

METHODS

The type of research, population and respondent characteristics, instrumentation, validity and reliability, data collection procedures, data analysis, and limitations of the study are described in this chapter.

Type of Research

A quantitative survey research design was utilized to describe and explore the attitudes of agricultural college students toward interactions and multimedia technology use in online courses. The study was based on Moore's (1989) transactional distance theory. An online questionnaire was used that contained a series of questions related to participants' experiences with using different types of technology and their perceptions of the relationships between different types of technology and interactions in the online learning environment. Permission to conduct the study was obtained from the Texas A&M University Institutional Review Board for human subject research (IRB 2016-0604).

Population and Respondent Characteristics

The target population was undergraduate students who were majoring in the College of Agriculture and Life Sciences at Texas A&M University (TAMU). As of Spring 2017, the total number of undergraduate students in the College of Agriculture

and Life Sciences at TAMU was 6,099 (College of Agriculture and Life Science at Texas A&M University, 2016). Fourteen departments are in the College of Agriculture and Life Sciences: Agricultural Economics; Agricultural Leadership, Education, and Communications; Animal Science; Biochemistry and Biophysics; Biological and Agricultural Engineering; Ecosystem Science and Management; Entomology; Horticultural Sciences; Nutrition and Food Science; Plant Pathology and Microbiology; Poultry Science; Recreation, Park and Tourism Sciences; Soil and Crop Sciences; and Wildlife and Fisheries Sciences.

According to the 95% confidence level and 5% margin of error rules, 362 participants from TAMU were needed for this study. Three hundred and sixty-two students who were majoring in the College of Agriculture and Life Science at Texas A&M University (TAMU) were invited to participate in the study. Participants received the online survey invitation through email with a link to the survey included. Due to a low response rate (Only 70 students completed the survey in the first three weeks.) with the online survey, an amendment to the data collection method to allow intercept data collection was submitted to and approved by the Institutional Review Board for human subjects research. The amendment allowed students to be invited to participate in the study either in person between classes or through a request to complete the survey via the researcher's personal social media accounts. Data were analyzed using SPSS for descriptive data analysis, factor analysis, independent sample t-test analysis, and logistic regression analysis. Tables 2 through 5 provide details regarding participants' characteristics. The variables include gender, classification, major, and GPA.

Gender

Table 2 shows the distribution of participating students (*n* = 262) by gender. One hundred and five participants (29.0%) were male, and 257 participants (71.0%) were female.

Table 2
Distribution by Gender of Participants at the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Gender	*f*	%
Male	105	29.0
Female	257	71.0

Note. *n* = 362.

Classification

Table 3 shows the distribution of participating students at Texas A&M University (*n* = 262) by classification. One hundred and twenty-three participants (34.0%) were juniors; 116 participants (32.1%) were seniors; 81 participants (22.4%) were sophomores; and 42 participants (11.6%) were freshman.

Table 3
Distribution by Classification of Participants at the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Classification	*f*	%
Junior	123	34.0
Senior	116	32.1
Sophomore	81	22.4
Freshman	42	11.6

Note. *n* = 362.

Major

Table 4 shows the distribution of participating students (*n* = 262) by major. Participants from 14 departments were randomly invited to participate in the study. Participants included 31 (8.6%) from the Department of Agricultural Economics; 85 (23.5%) from the Department of Agricultural Leadership, Education, and Communications; 71 (19.6%) from the Department of Animal Science; 17 (4.7%) from the Department of Biochemistry and Biophysics; four (1.1%) from the Department of Biological and Agricultural Engineering; 17 (4.7%) from the Department of Ecosystem Science and Management; five (1.4%) from the Department of Entomology; 10 (2.8%) from the Department of Horticultural Science; 29 (8.0%) from the Department of Nutrition and Food Science; 16 (4.4%) from the Department of Plant Pathology and Microbiology; three (0.8%) from the Department of Poultry Science; 30 (8.3%) from the Department of Recreation, Park and Tourism Sciences; 15 (4.1%) from the Department of Soil and Crop Sciences; and 29 (8.0%) from the Department of Wildlife and Fisheries Sciences.

Table 4
Distribution by Major of Participants at the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Major	*f*	%
Agricultural Leadership, Education, and Communications	85	23.5
Animal Science	71	19.6
Agricultural Economics	31	8.6
Recreation, Park and Tourism Sciences	30	8.3
Wildlife and Fisheries Sciences	29	8.0
Nutrition and Food Science	29	8.0
Biochemistry and Biophysics	17	4.7
Ecosystem Science and Management	17	4.7
Plant Pathology and Microbiology	16	4.4
Soil and Crop Sciences	15	4.1
Horticultural Sciences	10	2.8
Entomology	5	1.4
Biological and Agricultural Engineering	4	1.1
Poultry Science	3	0.8

Note. n = 362.

GPA

Table 5 shows the distribution of participating students (n = 262) by GPA. Twenty-two participants (6.1%) reported GPAs of 4.0; 105 participants (29.0%) reported GPAs ranging from 3.5 to 3.9; 122 participants (33.7%) reported GPAs ranging from 3.0 to 3.4; 75 participants (20.7%) reported GPAs ranging from 2.5 to 2.9; 23 participants (6.4%) reported GPAs ranging from 2.0 to 2.4; three participants (0.8%) reported GPAs ranging from 1.5 to 1.9; one participant (0.3%) reported a GPA between 1.0 to 1.4; and 11 participants (3.0%) reported that they did not have a GPA score at the time they participated in the study.

Table 5
Distribution by Reported GPAs of Participants, College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

GPA	*f*	%
3.0-3.4	122	33.7
3.5-3.9	105	29.0
2.5-2.9	75	20.7
2.0-2.4	23	6.4
4.0	22	6.1
I have no GPA score at this time	11	3.0
1.5-1.9	3	0.8
1.0-1.4	1	0.3

Note. *n* = 362.

Instrumentation

The instrument for this study was created based on the four types of interactions in Moore's (1989) transactional distance theory. The instrument contained a series of sections and statements related to technology use and the four types of interactions (i.e., learner-to-learner, learner-to-instructor, learner-to-course content, and learner-to-course technology) related to online classes (see Appendix A-1).

The instrument contained six main sections and used a five-point Likert-type scale to measure participants' attitudes about technology use in online learning. The five-point Likert-type scale response choices were: Strongly Disagree = 1, Disagree = 2, Neither Disagree or Agree = 3, Agree = 4, and Strongly Agree = 5.

Prior to the six response sections, the instrument asked respondents about their preference for learning formats. This provided researchers with a basic understanding of participants' self-reported preference for learning. The multiple-choice question was presented as follows:

What is your preference for the course delivery format?

- Face-to-face course.
- Blended method course (Includes both face-to-face class and online learning class).
- Online course.

Section I measured the level of interaction between the learner and other learners through the use of online learning systems and technologies. Respondents were asked to rate six statements on a five-point Likert-type scale. Each statement focused on the ability of the selected technology to improve the relationship between learners and other learners. The statements from Section I were as follows:

- The use of "Email" enhances my interactions with other learners.
- The use of "Audio/phone call (e.g., using Skype, Viber, or Tango)" enhances my interactions with other learners.
- The use of "Social media (e.g., Facebook, Instagram, LinkedIn, or Google +)" enhances my interactions with other learners.
- The use of "Instant messaging (e.g., using text, Whats App, Snapchat, Line, or Facebook Messenger)" enhances my interactions with other learners.
- The use of "Blogging (e.g., using WordPress, Pinterest, Blogger, or Tumblr)" enhances my interactions with other learners.
- The use of "Collaborative documents (e.g., using Google Docs or Quip)" enhances my interactions with other learners.

Section II was used to measure perceptions of interaction between the learner and the instructor through the use of online learning systems and technologies. Respondents were asked to rate seven statements on a five-point Likert-type scale. Each statement focused on the ability of the selected technology to improve the relationship between learners and the instructor. The statements from Section II were as follows:

- The use of "Lecture" enhances my interactions with the instructor.
- The use of "Video" enhances my interactions with the instructor.

- The use of "Email" enhances my interactions with the instructor.
- The use of "Voice-over PowerPoint" enhances my interactions with the instructor.
- The use of "Online editing and feedback" enhances my interactions with the instructor.
- The use of "Audio/phone call (e.g. using Skype, Viber, or Tango)" enhances my interactions with the instructor.
- The use of "Evaluation" enhances my interactions with the instructor.

Section III was used to measure perceptions of interaction between the learner and course content through the use of online learning systems and technologies. Respondents were asked to rate eight statements on a five-point Likert-type scale. Each statement focused on the ability of the selected technology to improve the relationship between learners and course content. The statements from Section III are listed below:

- The use of "Text / Textbooks" enhances my interactions with course content.
- The use of "Support materials (e.g., providing links or extension reading)" enhances my interactions with course content.
- The use of "Case studies" enhances my interactions with course content.
- The use of "PowerPoint" enhances my interactions with course content.
- The use of "Interactive video" enhances my interactions with course content.
- The use of "Online practice exercises (e.g. online quiz)" enhances my interactions with course content.
- The use of "Podcasting (e.g., using voice message / record)" enhances my interactions with course content.
- The use of "Collaborative documents (e.g., using Google docs or Quip)" enhances my interactions with course content.

Section IV was used to measure perceptions of interaction between the learner and course technology through the use of online learning systems and technologies. Respondents were asked to rate seven statements on a five-point Likert-type scale. Each statement focused on the ability of the selected technology to improve the relationship

between learners and the course technology. The statements in Section IV are listed below:

- The use of "Online tutorials" enhances my interactions with course technology.
- The use of "Getting help online" enhances my interactions with course technology.
- The use of "Online instructions for downloading plugins" enhances my interactions with course technology.
- The use of "Electronic libraries" enhances my interactions with course technology.
- The use of "Apps" enhances my interactions with course technology,
- The use of "File management systems (e.g., using Dropbox or Google Drive)" enhances my interactions with course technology.
- The use of "Search engines (e.g., using Google, Bing, or Yahoo Search)" enhances my interactions with course technology.

Section V was used to measure perceptions of satisfaction, quality, and learning experienced through interaction. Respondents were asked to rate twelve statements on a five-point Likert-type scale. The statements in Section V are listed below:

Satisfaction:

- I am generally more satisfied with a learning experience when opportunities for interaction with other students are provided.
- I am generally more satisfied with a learning experience when opportunities for interaction with the instructor are provided.
- I am generally more satisfied with a learning experience when opportunities for interaction with the content are provided.
- I am generally more satisfied with a learning experience when opportunities for interaction with the technology are provided.

Quality:

- The quality of a learning experience increases when opportunities for interaction with other students are provided.
- The quality of a learning experience increases when opportunities for interaction with the instructor are provided.

- The quality of a learning experience increases when opportunities for interaction with the content are provided.
- The quality of a learning experience increases when opportunities for interaction with the technology are provided.

Learning:

- Learning increases when opportunities for interaction with other students are provided.
- Learning increases when opportunities for interaction with the instructor are provided.
- Learning increases when opportunities for interaction with the content are provided.
- Learning increases when opportunities for interaction with the technology are provided.

Section VI was used to measure students' level of agreement with the question, "Is the use of the following technology an effective means for enhancing interactions with other learners, the instructor, the course content, or the course technology?" The respondents could choose multiple responses for each given technology. For example, if a respondent believed that "Online Chat" could be used to enhance interactions with other learners, the instructor, and the course content, but not the course technology, then he/she could select three choices including "with other learners," "with the instructor," and "with the content." Respondents were instructed to select each statement that applied to them. The technologies listed in Section VI included audio/phone call, Blogger, case studies, Dropbox, email, Facebook, getting help online, Google Docs, Google+, Instagram, instructor announcements, lecture, Line, LinkedIn, online calendars, online tutorials, online quizzes, Pinterest, PowerPoint, Quip, role play/simulations, Skype,

Snapchat, text/textbook, threaded discussions, Twitter, Viber, voice-over PowerPoint, Whats App, worksheets, and YouTube.

The final area of the instrument related to demographic information about the participants including gender, classification, major, and total GPA score.

Validity and Reliability

The instrument was reviewed for content validity by a panel of experts who possessed expertise in the area of technology use for online learning. The panel was composed of faculty members in the Department of Agricultural Leadership, Education, and Communications at Texas A&M University. The wording of several statements was modified based on the panel. The Texas A&M University Office of Research Compliance Institutional Review Board reviewed and approved the study in September 2016 (IRB 2016-0604).

To test the reliability and face validity of the instrument, a pilot study was conducted prior to official data collection. This pilot study was conducted with 30 students in the College of Agriculture and Life Sciences at TAMU who were not included in the sample population. The pilot study was carried out in January 2017. Respondents were provided access to the information sheet (see Appendix A-2) before answering the online questionnaire.

The commonly used rule for reliability is Cronbach's alpha scale (Likert, 1932). The rules of Cronbach's alpha scale are: $\alpha \geq 0.9$ = excellent, $0.8 \leq \alpha < 0.9$ = good, $0.7 \leq \alpha < 0.8$ = Acceptable, $0.6 \leq \alpha < 0.7$ = questionable, $0.5 \leq \alpha < 0.6$ = poor, and $\alpha < 0.5$ =

unacceptable (Likert, 1932). Table 6 shows the reliability levels for internal scales of the instrument. The reliabilities of the total interactions (α = 0.89) and the learner-to-course technology subscale consisting of 7 items (α = 0.83) were good. The reliabilities of the learner-to-learner interaction subscale consisting of 6 items (α = 0.74) and the learner-to-course content interaction subscale consisting of 8 items (α = 0.78) were acceptable. The reliabilities of the learner-to-instructor interaction subscale consisting of 7 items (α = 0.68) and the satisfaction, quality, and learning subscale consisting of 12 items (α = 0.67) were questionable.

Table 6
Reliability for Scales of Instrument based on Participants at the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Scales	Number of items	Cronbach's Alpha
Total four interactions	28	0.89
Section IV: Learner to course technology interactions	7	0.83
Section III: Learner to course content interactions	8	0.78
Section I: Learner to learner interactions	6	0.74
Section II: Learner to instructor interactions	7	0.68
Section V: Satisfaction, quality, and learning	12	0.67

Note. *n* = 362.

Data Collection Procedures

Data collection for this study was conducted via an online questionnaire hosted in Qualtrics (an online survey platform). Data was collected anonymously from respondents. Target respondents received an email invitation to participate in this study, and their consent was obtained when each respondent clicked the link to the survey. This

study originally used the TAMU Bulk Mail service to reach undergraduate students in the College of Agriculture and Life Sciences at TAMU.

Formal data collection with the approved instrument began in late January 2017. To increase student participation in the online survey, two follow-up reminders were sent to students through email. Due to a low response rate (Only 70 students completed the survey in first three weeks.), the researcher requested permission to add intercept data collection to the data collection process. Intercept data collection involved inviting students to participate in the study either in person between classes or through a request to complete the survey via the researcher's personal social media accounts. Permission was received from the TAMU Institutional Review Board to add intercept data collection. Data collection continued until sufficient responses were received. Data collection was completed in early March 2017. Responses from both methods of data collection (i.e., formal data collection and intercept data collection) were compared and no statistical difference in perceptions was found.

Data Analysis

All data were collected online either via a link within an email or via a link presented during intercept data collection. SPSS 23.0 was used to analyze the data. The survey included demographic questions and inquiries associated with 11 variables. The independent variables for the study were (a) technologies for learner-to-learner interaction, (b) technologies for learner-to instructor interaction, (c) technologies for learner-to-course content interaction, (d) technologies for learner-to-course technology

interaction, (e) gender, (f) classification, (g) major, and (h) GPA. The dependent variables for the study were (a) satisfaction of an online learning experience, (b) quality of an online learning experience, and (c) increased learning. The detailed data analysis methods are described by objective.

Objective One

The first objective was to identify and describe student perceptions of specific technology use to enhance learner-to-learner interaction for online learning. Descriptive analyses were conducted to identify the mean, standard deviation, frequencies, and percentages of specific technologies used to enhance learner-to-learner interactions. Interpretations of students' perceptions of the specific technology to enhance learner-to-learner interaction were based on the following scale: $1 \leq M \leq 1.49$ = strongly disagree, $1.5 \leq M \leq 2.49$ = disagree, $2.5 \leq M \leq 3.49$ = neither agree nor disagree, $3.5 \leq M \leq 4.49$ = agree, and $4.5 \leq M \leq 5$ = strongly agree.

Exploratory factor analysis was used to explore which technologies identified in Section I of the instrument were highly correlated to the enhancement of learner-to-learner interactions. An exploratory factor analysis using principal component analysis with varimax rotation for six items was adopted. Factors were identified as those with eigenvalues greater than 1.00. A value of 0.30 was used as a viable cutoff for judging the saliency of factor loadings.

Objective Two

The second objective of this study was to identify and describe student perceptions of specific technology use to enhance learner-to-instructor interactions for online learning. Descriptive analyses were conducted to identify the mean, standard deviation, frequencies, and percentages of specific technologies used to enhance learner-to-instructor interactions. Interpretations of students' perceptions of the specific technology to enhance learner-to-instructor interaction were based on the following scale: $1 \leq M \leq 1.49$ = strongly disagree, $1.5 \leq M \leq 2.49$ = disagree, $2.5 \leq M \leq 3.49$ = neither agree nor disagree, $3.5 \leq M \leq 4.49$ = agree, and $4.5 \leq M \leq 5$ = strongly agree.

Exploratory factor analysis was used to explore which specific technologies in Section II of the instrument were highly correlated with enhancement of learner-to-instructor interactions. An exploratory factor analysis using principal component analysis with varimax rotation for seven items was adopted. Factors were identified as those with eigenvalues greater than 1.00. A value of 0.30 was used as a viable cutoff for judging the saliency of factor loadings.

Objective Three

The third objective was to identify and describe student perceptions of specific technologies used to enhance learner-to-course content interactions for online learning. Descriptive analyses were conducted to identify the mean, standard deviation, frequencies, and percentages of specific technologies used to enhance learner-to-course content interactions. Interpretations of students' perceptions of a specific technology's

ability to enhance learner-to-course content interaction were based on the following scale: $1 \leq M \leq 1.49$ = strongly disagree, $1.5 \leq M \leq 2.49$ = disagree, $2.5 \leq M \leq 3.49$ = neither agree nor disagree, $3.5 \leq M \leq 4.49$ = agree, and $4.5 \leq M \leq 5$ = strongly agree.

Exploratory factor analysis was used to identify the specific technologies in Section III of the instrument that were highly correlated to enhancement of learner-to-course content interactions. An exploratory factor analysis using principal component analysis with varimax rotation for eight items was adopted. Factors were identified as those with eigenvalues greater than 1.00. A value of 0.30 was used as a viable cutoff for judging the saliency of factor loadings.

Objectives Four

The fourth objective was to identify and describe student perceptions of the use of specific technologies to enhance learner-to-course technology interactions for online learning. Descriptive analyses were conducted to identify the mean, standard deviation, frequencies, and percentages of specific technologies used to enhance learner-to-course technology interactions. Interpretations of students' perceptions of a specific technology to enhance learner-to-course technology interaction were based on the following scale: $1 \leq M \leq 1.49$ = strongly disagree, $1.5 \leq M \leq 2.49$ = disagree, $2.5 \leq M \leq 3.49$ = neither agree nor disagree, $3.5 \leq M \leq 4.49$ = agree, and $4.5 \leq M \leq 5$ = strongly agree.

Exploratory factor analysis was used to identify which specific technologies in Section IV of the instrument were highly correlated to enhancement of learner-to-course technology interactions. An exploratory factor analysis using principal component

analysis with varimax rotation for seven items was adopted. Factors were identified as those with eigenvalues greater than 1.00. A value of 0.30 was used as a viable cutoff for judging the saliency of factor loadings.

Objective Five

The fifth objective was to identify and describe students' satisfaction, perception of quality, and perception of learning increase when interactions are provided during an online learning experience. Descriptive analyses were conducted to identify the mean, standard deviation, frequencies, and percentages of learners' attitudes toward satisfaction with online learning experiences, quality of online learning experiences, and increased learning when learner-to-learner interaction, learner-to-instructor interaction, learner-to-course content interaction, and learner-to-course technology interaction were provided within the experience.

Objective Six

The sixth objective was to explore and describe which technologies in an online learning environment could be a significant predictor of students' satisfaction, perceived quality, and perception of learning increase when interactions are provided during an online learning experience. Logistical regression analyses were used to explore and describe which types of technology, when used in online learning courses, could be a significant predictor of learners' satisfaction with online learning experiences, quality of online learning experiences, and increased learning in online courses when learner-to-

learner interaction, learner-to-instructor interaction, learner-to-course content interaction, and learner-to-course technology interaction are provided in online courses.

Objective Seven

The seventh objective was to determine and describe students' preferences for technologies used to enhance interactions for online learning. Descriptive analyses were conducted to present the frequencies and percentages of the variety of technologies for answering the question, "Is the use of the following technology an effective means for enhancing interactions with other learners, the instructor, the technology, or the content?"

Objective Eight

The eighth objective was to examine the relationship between students' selected personal characteristics and preferences for technology for enhancing four types of interactions in online courses. Independent-sample t-test analyses were conducted to examine the relationship between students' selected personal characteristics (i.e., gender, classification, major, and GPA) and preference toward technology for enhancing learner-to-learner interaction, learner-to-instructor interaction, learner-to-course content interaction, and learner-to-course technology interaction in the online courses.

Objective Nine

The ninth objective was to examine the relationship between students' selected personal characteristics and students' satisfaction, perceived quality, and perception of learning increase when interactions are provided during an online learning experience. Independent-sample t-test analyses were conducted to examine the relationship between students' selected personal characteristics (i.e., gender, classification, major, and GPA) and attitudes toward satisfaction of online learning experiences, quality of online learning experiences, and increased learning when learner-to-learner interaction, learner-to-instructor interaction, learner-to-course content interaction, and learner-to-course technology interaction were provided in online courses.

Limitations of the Study

1. This study is limited and bound by the attributes of the survey instrument in regard to survey questions and characteristics such as the survey length.
2. Each respondent answered the survey questions based on their own personal experience with online learning.
3. The list of technologies used in the survey was compiled based on the literature and the researchers' knowledge of technology. It is recognized that the study is limited to these technologies.
4. Students' experiences with technology in an online course are the basis of their interpretation of the technology. Thus, the study is limited to students' experiences.
5. This study focused on students' perceptions.

6. Survey methods were used to collect data. Thus, the study did not collect open responses or data such as qualitative interviews. The study is limited to quantitative data and analysis.
7. Given that the target population consisted of agricultural students within the College of Agriculture and Life Sciences at Texas A&M University, the study is limited to this group.

CHAPTER IV

FINDINGS

This chapter presents the purpose of the study, a summary of the characteristics of the participants, participants' preferences for course delivery format, and findings for each objective.

Purpose of Study

The purpose of this quantitative study was to examine and identify undergraduate students' perceptions regarding technology use for enhancing interactions in online learning environments. Undergraduate students who were majoring in the College of Agriculture and Life Sciences at Texas A&M University were the target population for this study.

Characteristics of the Participants

The target population was undergraduate students who were enrolled in the College of Agriculture and Life Sciences at Texas A&M University. A total of 362 students completed the survey. Twenty-nine percent were male and 71% were female. The majority (62.2%) of respondents were junior or senior level classification, and there were respondents from all 14 departments in the college. The majority (68.8%) of the respondents indicated a high GPA (above 3.0).

Participants' Preferences for Course Delivery Format

Table 7 shows participants' self-reported preferences for course delivery format (n = 362). Two hundred and fifty-nine participants (71.5%) preferred a face-to-face course for learning; 78 participants (21.5%) preferred a blended method course for learning; and only 25 participants (6.9%) preferred an online course for learning.

Table 7
Frequencies and Percentages of Self-reported Preferences for Course Delivery Format as reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Course delivery format	*f*	%
Face-to-face course	259	71.5
Blended method course (Includes both face-to-face and online learning course characteristics)	78	21.5
Online course	25	6.9

Note. n = 362.

Findings Related to Objective One

The first objective was to identify and describe student perceptions of specific technology use to enhance learner-to-learner interaction for online learning. Participants' attitudes toward the use of specific technologies to enhance interaction between the learner and other learners were measured via responses to five-point Likert-type scale statements. The six specific technologies that could be used to enhance interaction with other learners were email, audio/phone calls, social media, instant messaging, blogging,

and collaborative documents. Frequencies and percentages were used to describe the results.

As Table 8 shows, about 80.4% of participants agreed or strongly agreed that collaborative documents enhanced learner-to-learner interaction. About 74.8% of participants agreed or strongly agreed that instant messaging enhanced learner-to-learner interaction. About 61.9% of participants agreed or strongly agreed that social media enhanced learner-to-learner interaction. Approximately 47% of participants agreed or strongly agreed that email enhanced learner-to-learner interaction, and about 22.1% of participants neither agreed nor disagreed with this statement. Approximately 33.4% of participants agreed or strongly agreed that audio/phone calls enhanced learner-to-learner interaction, and about 30.4% of participants neither agreed nor disagreed with this statement. Approximately 16% of participants agreed or strongly agreed that blogging enhanced learner-to-learner interaction, and about 32.9% of participants neither agreed nor disagreed with this statement.

Overall, the mean and standard deviation for participants' attitudes toward the use of specific technologies to enhance learner-to-learner interaction were $M = 3.34$ and $SD = 0.56$. Participants tended to neither agree nor disagree that technology could be used in online courses to increase learner-to-learner interaction.

Table 8

Descriptive Statistical Results of Preference toward Technologies to Enhance Learner-to-Learner Interaction in Online Learning Environments as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

			Strongly Disagree		*Disagree*		*Neither Agree nor Disagree*		*Agree*		*Strongly Agree*	
	M	*SD*	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Collaborative documents	4.04	1.044	17	4.7	17	4.7	37	10.2	155	42.8	136	37.6
Instant messaging	3.83	1.097	21	5.8	29	8.0	41	11.3	172	47.5	99	27.3
Social Medias	3.49	1.100	25	6.9	47	13.0	66	18.2	173	47.8	51	14.1
Email	3.16	1.124	31	8.6	81	22.4	80	22.1	140	38.7	30	8.3
Audio/phone call	2.94	1.022	26	7.2	105	29.0	110	30.4	105	29.0	16	4.4
Blogging	2.56	0.940	41	11.3	144	39.8	119	32.9	50	13.8	8	2.2

Note. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. An overall construct score was computed and found to be $M = 3.34$; $SD = 0.557$; $n = 362$.

To generate the factor structure of technologies that enhance learner-to-learner interaction, a principal component analysis with varimax rotation was conducted for the six items ($n = 362$), as shown in Table 9. This analysis resulted in one factor solution that explained 43.86% of the total variance.

Table 9

Exploratory Factor Analysis Results for Technologies to Enhance Learner-to-Learner Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

	Eigenvalues	% of Variance	Cumulative %
Factor 1	2.632	43.859	43.859

As Table 10 shows, Factor 1 included six items regarding technologies that assist with learner-to-learner interaction including email, audio/phone calls, social media, instant messaging, blogging, and collaborative documents; thus, this scale was labeled as

"learner-to-learner interaction tools." Internal consistency reliability for the factor learner-to-learner interaction tool was examined using Cronbach's alpha. The reliability for this factor was acceptable ($\alpha = 0.74$).

Table 10
Factor Loadings for Factor 1 Based on a Principal Component Analysis with Varimax Rotation for 6 Items from the Technologies to Enhance Learner-to-Learner Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	Factor Loadings	Cronbach Alpha
Instant messaging	0.775	0.739
Social Medias	0.769	
Collaborative documents	0.705	
Email	0.609	
Audio/phone call	0.605	
Blogging	0.454	

Note. Factor loadings < 0.3 are suppressed.

Findings Related to Objective Two

The second objective was to identify and describe student perceptions of using specific technologies to enhance learner-to-instructor interactions for online learning. Participants' attitudes toward the use of specific technologies to enhance interaction between the learner and the instructor were measured through responses to five-point Likert-type scale statements. The seven specific technologies that can be used to enhance students' interaction with the instructor were lecture, video, email, voice-over PowerPoint, online editing and feedback, audio/phone calls, and evaluation. Frequencies and percentages were used to describe the results.

As Table 11 shows, about 92% of participants agreed or strongly agreed that lecture enhanced learner-to-instructor interaction. About 80.2% of participants agreed or strongly agreed that email enhanced learner-to-instructor interaction. About 65.5% of participants agreed or strongly agreed that online editing and feedback enhanced learner-to-instructor interaction. About 62.7% of participants agreed or strongly agreed that evaluation enhanced learner-to-instructor interaction. About 57.7% of participants agreed or strongly agreed that video enhanced learner-to-instructor interaction. About 46.1% of participants agreed or strongly agreed that voice-over PowerPoint enhanced learner-to-instructor interaction. Approximately 26.5% of participants agreed or strongly agreed that audio/phone calls enhanced learner-to-instructor interaction, and about 41.2% of participants neither agreed nor disagreed with this statement.

Overall, the mean and standard deviation for participants' attitudes toward the use of specific technologies to enhance learner-to-instructor interaction were $M = 3.61$ and $SD = 0.45$. Participants tended to agree that using technology in online courses could increase learner-to-instructor interaction.

Table 11

Descriptive Statistical Results of Preferences toward Technologies to Enhance Learner-to-Instructor Interaction in Online Learning Environments as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

			Strongly Disagree		*Disagree*		*Neither Agree nor Disagree*		*Agree*		*Strongly Agree*	
	M	*SD*	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Lecture	4.28	0.841	10	2.8	6	1.7	13	3.6	176	48.6	157	43.4
Email	3.93	0.897	10	2.8	18	5.0	44	12.2	204	56.4	86	23.8
Online editing and feedback	3.71	0.957	10	2.8	29	8.0	86	23.8	168	46.4	69	19.1
Evaluation	3.67	0.939	7	1.9	35	9.7	93	25.7	164	45.3	63	17.4
Video	3.52	1.002	9	2.5	56	15.5	88	24.3	156	43.1	53	14.6
Voice over PowerPoint	3.23	1.128	23	6.4	84	23.2	88	24.3	122	33.7	45	12.4
Audio/phone call	2.93	0.949	22	6.1	95	26.2	149	41.2	80	22.1	16	4.4

Note. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. An overall construct score was computed $M = 3.61$; $SD = 0.446$; $n = 362$.

To generate the factor structure of technologies that enhance learner-to-instructor interaction, a principal component analysis with varimax rotation was conducted for the seven items ($n = 362$), as shown in Table 12. This analysis resulted in three factor solutions that explained 35.21% of the variance for factor 1, 17.20% of the variance for factor 2, 14.34% of the variance for factor 3, and 66.75% of the total variance.

Table 12

Exploratory Factor Analysis Results for Technologies to Enhance Learner-to-Instructor Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

	Eigenvalues	% of Variance	Cumulative %
Factor 1	2.465	35.214	35.214
Factor 2	1.204	17.197	52.410
Factor 3	1.004	14.337	66.747

As Table 13 shows, Factor 1 included two items regarding two-way feedback between learners and the instructor, including evaluation and online editing and feedback; thus, this scale was labeled “feedback tool.” Internal consistency reliability for the factor feedback function was examined using Cronbach’s alpha. The reliability for this factor was questionable (α =0.63).

Table 13
Factor Loadings for Factor 1 Based on a Principal Component Analysis with Varimax Rotation for 7 Items from the Technologies to Enhance Learner-to-Instructor Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	Factor Loadings	Cronbach Alpha
Evaluation	0.827	0.626
Online editing and feedback	0.792	

Note. Factor loadings < 0.3 are suppressed.

As Table 14 shows, Factor 2 included three items regarding communications and interactions through voice and sounds, including voice-over PowerPoint, video, and audio/phone calls; thus, this scale was labeled “sonic interaction tool.” Internal consistency reliability for the factor sonic interaction tool was examined using Cronbach’s alpha. The reliability for this factor was poor (α =0.56).

Table 14
Factor Loadings for Factor 2 Based on a Principal Component Analysis with Varimax Rotation for 7 Items from the Technologies to Enhance Learner-to-Instructor Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	Factor Loadings	Cronbach Alpha
Voice over PowerPoint	0.791	0.558
Video	0.787	
Audio/phone call	0.532	

Note. Factor loadings < 0.3 are suppressed.

As Table 15 shows, Factor 3 included two items that referred to traditional methods of interaction with the instructor, including lecture and e-mail; thus, this scale was labeled "learner-to-instructor interaction tool." Internal consistency reliability for the factor learner-to-instructor interaction tool was examined using Cronbach's alpha. The reliability for this factor was poor ($\alpha = 0.58$).

Table 15
Factor Loadings for Factor 3 Based on a Principal Component Analysis with Varimax Rotation for 7 Items from the Technologies to Enhance Learner-to-Instructor Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	Factor Loadings	Cronbach Alpha
Lecture	0.824	0.582
Email	0.561	

Note. Factor loadings < 0.3 are suppressed.

Findings Related to Objective Three

The third objective of this study was to identify and describe student perceptions of using specific technologies to enhance learner-to-course content interactions for online learning. Participants' attitudes toward the use of specific technologies to enhance interaction between the learner and course content were measured via responses to five-point Likert-type scale statements. The eight specific technologies identified that enhance interaction with course content were text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercises, podcasting, and collaborative documents. Frequencies and percentages were used to describe the results.

As Table 16 shows, about 88.4% of participants agreed or strongly agreed that PowerPoint enhanced learner-to-course content interaction. About 85.9% of participants agreed or strongly agreed that online practice enhanced learner-to-course content interaction. About 79.5% of participants agreed or strongly agreed that support materials enhanced learner-to-course content interaction. About 74.1% of participants agreed or strongly agreed that collaborative documents enhanced learner-to-course content interaction. About 71.5% of participants agreed or strongly agreed that interactive video enhanced learner-to-course content interaction. About 68.8% of participants agreed or strongly agreed that case studies enhanced learner-to-course content interaction. About 66.8% of participants agreed or strongly agreed that text/textbooks enhanced learner-to-course content interaction. Approximately 30.4% of participants agreed or strongly agreed that podcasting enhanced learner-to-instructor interaction, and about 39.2% of participants neither agreed nor disagreed with this statement.

Overall, the mean and standard deviation for participants' attitudes toward specific technologies used for enhancing learner-to-course content interaction were *M* = 3.8 and *SD* = 0.36. Participants tended to agree that technologies used in online courses could be used to increase learner-to-course content interaction.

Table 16
Descriptive Statistical Results of Preference toward Technologies to Enhance Learner-to-Course Content Interaction in Online Learning Environments as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

			Strongly Disagree		Disagree		Neither Agree nor Disagree		Agree		Strongly Agree	
	M	*SD*	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
PowerPoint	4.16	0.823	8	2.2	8	2.2	26	7.2	196	54.1	124	34.3
Online practice exercises	4.12	0.825	7	1.9	9	2.5	35	9.7	194	53.6	117	32.3
Support materials	3.94	0.875	4	1.1	28	7.7	42	11.6	200	55.2	88	24.3
Collaborative documents	3.90	0.921	7	1.9	22	6.1	65	18.0	174	48.1	94	26.0
Interactive video	3.83	0.964	9	2.5	28	7.7	66	18.2	172	47.5	87	24.0
Case studies	3.78	0.928	10	2.8	21	5.8	82	22.7	176	48.6	73	20.2
Text / Textbooks	3.62	1.036	16	4.4	45	12.4	59	16.3	184	50.8	58	16.0
Podcasting	3.02	0.983	18	5.0	92	25.4	142	39.2	85	23.5	25	6.9

Note. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. An overall construct score was computed *M* = 3.80; *SD* = 0.359; *n* = 362.

To generate the factor structure of technologies to enhance learner-to-course content interaction, a principal component analysis with varimax rotation was conducted for the eight items (*n* = 362), as shown in Table 17. This analysis resulted in two factor solutions that explained 39.59% of the variance for Factor 1, 14.50% of the variance for Factor 2, and 54.10% of the total variance.

Table 17
Exploratory Factor Analysis Results for Technologies to Enhance Learner-to-Course Content Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

	Eigenvalues	% of Variance	Cumulative %
Factor 1	3.167	39.592	39.592
Factor 2	1.160	14.504	54.096

As Table 18 shows, Factor 1 included six items that pertained to a variety of resources and tools to enable knowledge and learning including case studies, PowerPoint, interactive video, online practice exercises, podcasting, and collaborative documents; thus, this scale was labeled "active learning tool." Internal consistency reliability for the factor active learning tool was examined using Cronbach's alpha. The reliability for this factor was acceptable ($\alpha = 0.76$).

Table 18
Factor Loadings for Factor 1 Based on a Principal Component Analysis with Varimax Rotation for 8 Items from the Technologies to Enhance Learner-to-Course Content Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	Factor Loadings	Cronbach Alpha
Collaborative documents	0.718	0.762
Interactive video	0.716	
Online practice exercises	0.704	
PowerPoint	0.667	
Case studies	0.611	
Podcasting	0.514	

Note. Factor loadings < 0.3 are suppressed.

As Table 19 shows, Factor 2 included two items that referred to text and reading including text/textbooks and support materials; thus, this scale was labeled “reading.” Internal consistency reliability for the factor reading was examined using Cronbach’s alpha. The reliability for this factor was poor ($\alpha = 0.67$).

Table 19
Factor Loadings for Factor 2 Based on a Principal Component Analysis with Varimax Rotation for 8 Items from the Technologies to Enhance Learner-to-Course Content Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	Factor Loadings	Cronbach Alpha
Text / Textbooks	0.901	0.669
Support materials	0.770	

Note. Factor loadings < 0.3 are suppressed.

Findings Related to Objective Four

The fourth objective was to identify and describe student perceptions of using specific technologies to enhance learner-to-course technology interactions for online learning. Participants’ attitudes toward the use of specific technologies to enhance interaction between the learner and course technology were measured via responses to five-point Likert-type scale statements. The seven specific technologies identified to enhance learner interaction with course technology were online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, apps, file management systems, and search engines. Frequencies and percentages were used to describe the results.

As Table 20 shows, about 89.5% of participants agreed or strongly agreed that search engines enhanced learner-to-course technology interaction. About 77% of participants agreed or strongly agreed that file management systems enhanced learner-to-course technology interaction. About 72.7% of participants agreed or strongly agreed that online tutorials enhanced learner-to-course technology interaction. About 63.6% of participants agreed or strongly agreed that apps enhanced learner-to-course technology interaction. About 62.2% of participants agreed or strongly agreed that getting help online enhanced learner-to-course technology interaction. About 57.5% of participants agreed or strongly agreed that electronic libraries enhanced learner-to-course technology interaction. Approximately 49.8% of participants agreed or strongly agreed that online instructions for downloading plugins enhanced learner-to-course technology interaction.

Overall, the mean and standard deviation for participants' attitudes toward specific technologies use for enhancing learner-to-course technology interaction were $M = 3.74$ and $SD = 0.33$. Participants tended to agree that technology use in online courses could be used to increase learner-to-course technology interaction.

Table 20

Descriptive Statistical Results of Preference toward Technologies to Enhance Learner-to-Course Technology Interaction in Online Learning Environments as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

			Strongly Disagree		Disagree		Neither Agree nor Disagree		Agree		Strongly Agree	
	M	*SD*	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Search engines	4.36	0.834	6	1.7	8	2.2	24	6.6	137	37.8	187	51.7
File management systems	3.96	0.898	7	1.9	18	5.0	*58*	16.0	*180*	49.7	*99*	27.3
Online tutorials	3.76	0.951	13	3.6	27	7.5	59	16.3	199	55.0	64	17.7
Apps	3.63	1.032	13	3.6	43	11.9	76	21.0	162	44.8	68	18.8
Getting help online	3.56	1.014	14	3.9	47	13.0	76	21.0	173	47.8	52	14.4
Electronic libraries	3.56	1.017	14	3.9	39	10.8	101	27.9	147	40.6	61	16.9
Online instructions for downloading plugins	3.38	0.992	15	4.1	51	14.1	116	32.0	141	39.0	39	10.8

Note: The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. An overall construct score was computed $M = 3.74$; $SD = 0.326$; $n = 362$.

To generate the factor structure of technologies to enhance learner-to-course technology interaction, a principal component analysis with varimax rotation was conducted for the seven items ($n = 362$), as shown in Table 21. This analysis resulted in one factor solution that explained 50.08% of the total variance.

Table 21

Exploratory Factor Analysis Results for Technologies to Enhance Learner-to-Course Technology Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

	Eigenvalues	% of Variance	Cumulative %
Factor 1	3.506	50.083	50.083

As Table 22 shows, Factor 1 included seven items that referred to multiple tools that can enhance learner-to-course technology interaction including online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, apps, file management systems, and search engines; thus, this scale was labeled "learner-to-course technology interaction tool." Internal consistency reliability for the factor learner-to-course technology interaction tool was examined using Cronbach's alpha. The reliability for this factor was acceptable ($\alpha = 0.83$).

Table 22
Factor Loadings for Factor 1 Based on a Principal Component Analysis with Varimax Rotation for 7 Items from the Technologies to Enhance Learner-to-the Course Technology Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	Factor Loadings	Cronbach Alpha
Online tutorials	0.766	0.831
Online instructions for downloading plugins	0.762	
Getting help online	0.738	
Electronic libraries	0.735	
Apps	0.716	
File management systems	0.673	
Search engines	0.536	

Note. Factor loadings < 0.3 are suppressed.

Findings Related to Objective Five

The fifth objective was to identify and describe students' satisfaction, perception of quality, and perception of learning increase when interactions are provided during an

online learning experience. Frequencies and percentages were used to describe the results.

Satisfaction

As Table 23 shows, about 98.1% of participants agreed that they perceived great satisfaction with the online learning experience when opportunities for interaction with the course content were provided. About 97.0% of participants agreed that they perceived great satisfaction with the online learning experience when opportunities for interaction with the instructor were provided. About 83.4% of participants agreed that they perceived great satisfaction with the online learning experience when opportunities for interaction with other students were provided. About 76.0% of participants agreed that they perceived great satisfaction with the online learning experience when opportunities for interaction with the course technology were provided.

Table 23
Descriptive Statistical Results of Agreement toward the Satisfaction of the Online Learning Experience When Four Types of Interactions were Provided as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

			Disagree		Agree	
Satisfaction	*M*	*SD*	*f*	%	*f*	%
Opportunities for interaction with course content provided	1.98	0.138	7	1.9	355	98.1
Opportunities for interaction with the instructor provided	1.97	0.172	11	3.0	351	97.0

Note: The scale for answers was: Disagree = 1; Agree = 2. An overall construct score was computed as M =1.90; SD = 0.095; n = 362.

Table 23 Continued

Satisfaction	*M*	*SD*	Disagree *f*	Disagree %	Agree *f*	Agree %
Opportunities for interaction with other learners provided	1.83	0.372	60	16.6	302	83.4
Opportunities for interaction with the course technology provided	1.76	0.428	87	24.0	275	76.0

Note: The scale for answers was: Disagree = 1; Agree = 2. An overall construct score was computed as *M* =1.90; *SD* = 0.095; *n* = 362.

Quality

As Table 24 shows, about 98.6% of participants agreed that they noted higher quality of the online learning experience when opportunities for interaction with the instructor were provided. About 97.5% of participants agreed that they noted higher quality of the online learning experience when opportunities for interaction with the course content were provided. About 83.1% of participants agreed that they noted higher quality of the online learning experience when opportunities for interaction with other students were provided. About 77.9% of participants agreed that they noted higher quality of the online learning experience when opportunities for interaction with the course technology were provided.

Table 24
Descriptive Statistical Results of Agreement toward the Quality of the Online Learning Experience When Four Types of Interactions were Provided as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

			Disagree		Agree	
Quality	*M*	*SD*	*f*	%	*f*	%
Opportunities for interaction with the instructor provided	1.99	0.117	5	1.4	357	98.6
Opportunities for interaction with the course content provided	1.98	0.156	9	2.5	353	97.5
Opportunities for interaction with other learners provided	1.83	0.375	61	16.9	301	83.1
Opportunities for interaction with the course technology provided	1.78	0.415	80	22.1	282	77.9

Note: The scale for answers was: Disagree = 1; Agree = 2. An overall construct score was computed M =1.90; SD = 0.095; n = 362.

Learning

As Table 25 shows, about 98.6% of participants agreed that they perceived that learning increased when opportunities for interaction with the instructor were provided. About 97.8% of participants agreed that they perceived that learning increased when opportunities for interaction with the course content were provided. About 84.5% of participants agreed that they perceived that learning increased when opportunities for interaction with other students were provided. About 79.3% of participants agreed that they perceived that learning increased when opportunities for interaction with the course technology were provided.

Table 25
Descriptive Statistical Results of Agreement toward Learning Increased When Four Types of Interactions were Provided as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

			Disagree		Agree	
Learning	*M*	*SD*	*f*	%	*f*	%
Opportunities for interaction with the instructor provided	1.99	0.117	5	1.4	357	98.6
Opportunities for interaction with the course content provided	1.98	0.147	8	2.2	354	97.8
Opportunities for interaction with other learners provided	1.85	0.362	56	15.5	306	84.5
Opportunities for interaction with the course technology provided	1.79	0.406	75	20.7	287	79.3

Note: The scale for answers was: Disagree = 1; Agree = 2. An overall construct score was computed M =1.90; SD = 0.095; n = 362.

Findings Related to Objective Six

The sixth objective was to explore and describe which technologies in an online learning environment can be a significant predictor of students' satisfaction, perceived quality, and perception of learning increase when interactions are provided during an online learning experience.

When Learner-to-Learner Interaction was Provided in the Online Course

As Table 26 shows, a logistic regression analysis was conducted to predict students' attitudes toward satisfaction of the online learning experience when learner-to-learner interactions were provided in the online course, using email, audio/phone calls, social media, instant messaging, blogging, and collaborative documents as predictors.

Nagelkerke's R^2 is 0.05. The Wald criterion demonstrated that only audio/phone calls made a significant contribution to prediction ($p = 0.05$). Email, social media, instant messaging, blogging, and collaborative documents were not significant predictors. Exp (B) value indicates that when learners' preference of using audio/phone calls to enhance learner-to-learner interaction is raised by one unit, the odds ratio is 1.37 times more likely to have greater agreement with the satisfaction of online learning experiences when learner-to-learner interaction is provided than if learners do not use audio/phone calls. Learners who prefer to use audio/phone calls to enhance learner-to-learner interaction are also 1.37 times more likely to experience higher satisfaction in their online learning experiences than others.

Table 26

Technology as a Predictor of Satisfaction of the Online Learning Experience when the Learner-to-Learner Interaction was Provided in an Online Course as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Construct		B	S.E.	Wald	P	Exp(B)
Step 1	Email	0.092	0.142	0.422	0.516	1.096
	Audio/phone call	0.315	0.160	3.900	0.048*	1.371
	Social Medias	0.103	0.166	0.384	0.535	1.109
	Instant messaging	0.189	0.167	1.271	0.259	1.208
	Blogging	-0.129	0.160	0.651	0.420	0.879
	Collaborative documents	-0.222	0.159	1.958	0.162	0.801
	(Constant)	0.611	0.663	0.849	0.357	1.843

Note. Variable(s) entered on step 1: (Constant), Email, Audio/phone call, Social Medias, Instant messaging, Blogging, Collaborative documents. Nagelkerke's $R^2 = 0.05$.

As Table 27 shows, a logistic regression analysis was conducted to predict students' attitudes toward quality of the online learning experience when learner-to-learner interaction is provided in the online course using email, audio/phone calls, social media, instant messaging, blogging, and collaborative documents as predictors.

Nagelkerke's R^2 is 0.07. The Wald criterion demonstrated that audio/phone calls ($p = 0.01$) and collaborative documents ($p = 0.02$) made significant contributions to prediction. Email, social media, instant messaging, and blogging were not significant predictors.

Exp (B) value indicates that when participants' preference for using audio/phone calls to enhance learner-to-learner interaction is raised by one unit, the odds ratio is 1.53 times more likely to have higher agreement with the quality of online learning experiences when learner-to-learner interaction is provided than when learners do not use audio/phone calls. When learners' preference for using collaborative documents to enhance learner-to-learner interaction is raised by one unit, the odds ratio is 0.67 times more likely to have higher agreement with the quality of online learning experiences when learner-to-learner interaction is provided than if learners do not use collaborative documents.

Learners who prefer to use audio/phone calls to enhance learner-to-learner interaction are 1.37 times likely to have a positive attitude toward the quality of their online learning experiences than others. However, learners who prefer to use collaborative documents to enhance learner-to-learner interaction are 0.67 times more

likely to have a more positive attitude toward the quality of their online learning experiences than others.

Table 27

Technology as Predictor for the Quality of Online Learning Experiences When Learner-to-Learner Interaction was Provided in an Online Course as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Construct		B	S.E.	Wald	P	Exp(B)
Step 1	Email	0.058	0.141	0.168	0.682	1.059
	Audio/phone call	0.420	0.161	6.810	0.009*	1.521
	Social Medias	0.012	0.166	0.006	0.940	1.013
	Instant messaging	0.253	0.168	2.282	0.131	1.288
	Blogging	-0.084	0.160	0.279	0.598	0.919
	Collaborative documents	-0.408	0.167	5.932	0.015*	0.665
	(Constant)	1.123	0.710	2.505	0.113	3.075

Note. Variable(s) entered on step 1: (Constant), Email, Audio/phone call, Social Medias, Instant messaging, Blogging, Collaborative documents. Nagelkerke's R^2 = 0.068.

As Table 28 shows, a logistic regression analysis was conducted to predict if participants' attitudes toward learning improved when learner-to-learner interaction was provided in online learning, using email, audio/phone calls, social media, instant messaging, blogging, and collaborative documents as predictors.

Nagelkerke's R^2 is 0.01. The Wald criterion demonstrated that only audio/phone calls made a significant contribution to prediction (p =0.01). Email, social media, instant messaging, blogging, and collaborative documents were not significant predictors. Exp (B) value indicates that when learners' preference of using audio/phone calls to enhance learner-to-learner interaction is raised by one unit, the odds ratio is 1.56 times more likely to have higher agreement with increased learning in online learning when learner-

to-learner interaction is provided than learners who do not use audio/phone calls. Learners who prefer to use audio/phone calls to enhance learner-to-learner interaction are 1.56 times more likely to agree that learner-to-learner interaction is an effective technology to increase learning in an online course.

Table 28
Technology as a Predictor for Agreement with Learning Increase When Learner-to-Learner Interaction was Provided in an Online Course as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Construct		B	S.E.	Wald	P	Exp(B)
Step 1	Email	0.205	0.147	1.939	0.164	1.227
	Audio/phone call	0.447	0.168	7.050	0.008*	1.563
	Social Media	0.135	0.173	0.612	0.434	1.145
	Instant messaging	0.134	0.173	0.603	0.437	1.144
	Blogging	-0.268	0.167	2.580	0.108	0.765
	Collaborative documents	-0.243	0.163	2.218	0.136	0.785
	(Constant)	0.537	0.676	0.631	0.427	1.711

Note. Variable(s) entered on step 1: (Constant), Email, Audio/phone call, Social Medias, Instant messaging, Blogging, Collaborative documents. Nagelkerke's $R^2 = 0.008$.

When Learner-to-Instructor Interaction was Provided in the Online Course

As Table 29 shows, a logistic regression analysis was conducted to predict participants' attitudes toward satisfaction with the online learning experience when learner-to-instructor interaction is provided, using lecture, video, email, voice-over PowerPoint, online editing and feedback, audio/phone calls, and evaluation as predictors.

Nagelkerke's R^2 is 0.17. The Wald criterion demonstrated that only online editing and feedback made a significant contribution to prediction ($p = 0.04$). Lecture,

video, email, voice-over PowerPoint, audio/phone calls, and evaluation were not significant predictors. Exp (B) value indicates that when learners' preference for using online editing and feedback to enhance learner-to-instructor interaction is raised by one unit, the odds ratio is 0.42 times more likely to have higher agreement with the satisfaction of the online learning experiences when learner-to-instructor interaction is provided than learners who do not use online editing and feedback. Learners who prefer to use online editing and feedback to enhance learner-to-instructor interaction are 0.42 times more likely to have the higher satisfaction toward their online learning experiences than others.

Table 29
Technology as Predictor for Satisfaction of an Online Learning Experience When Learner-to-Instructor Interaction was Provided in an Online Course as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Construct		B	S.E.	Wald	P	Exp(B)
Step 1	Lecture	0.597	0.316	3.573	0.059	1.817
	Video	0.105	0.346	0.093	0.760	1.111
	Email	0.513	0.354	2.096	0.148	1.670
	Voice over PowerPoint	0.311	0.335	0.864	0.353	1.365
	Online editing and feedback	-0.864	0.429	4.061	0.044*	0.421
	Audio/phone call	0.397	0.367	1.170	0.279	1.487
	Evaluation	0.295	0.341	0.745	0.388	1.343
	(Constant)	-0.921	1.440	0.409	0.523	0.398

Note. Variable(s) entered on step 1: (Constant), Lecture, Video, Email, Voice over PowerPoint, Online editing and feedback, Audio/phone call, Evaluation. Nagelkerke's $R^2 = 0.174$.

As Table 30 shows, a logistic regression analysis was conducted to predict participants' attitudes toward the quality of the online learning experience when learner-to-instructor interaction was provided using lecture, video, email, voice-over PowerPoint, online editing and feedback, audio/phone calls, and evaluation as predictors. From the results of logistic regression analysis, lecture, video, email, voice-over PowerPoint, online editing and feedback, audio/phone calls, and evaluation were not significant predictors for students' attitudes toward quality of the online learning experience when learner-to-instructor interaction was provided.

Table 30
Technology as a Predictor for Quality of an Online Learning Experiences When Learner-to-Instructor Interaction was Provided in an Online Course as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Construct		B	S.E.	Wald	P	Exp(B)
Step 1	Lecture	0.557	0.527	1.115	0.291	1.745
	Video	-0.407	0.491	0.687	0.407	0.666
	Email	-0.206	0.603	0.117	0.733	0.814
	Voice over PowerPoint	0.446	0.530	0.709	0.400	1.562
	Online editing and feedback	0.314	0.533	0.346	0.556	1.368
	Audio/phone calls	0.396	0.561	0.499	0.480	1.486
	Evaluation	0.347	0.530	0.428	0.513	1.414
	(Constant)	-0.222	1.867	0.014	0.905	0.801

Note. Variable(s) entered on step 1: (Constant), Lecture, Video, Email, Voice over PowerPoint, Online editing and feedback, Audio/phone call, Evaluation. Nagelkerke's $R^2 = 0.197$.

As Table 31 shows, a logistic regression analysis was conducted to predict increases in participants' attitudes toward learning when learner-to-instructor interaction

was provided in online learning, using lecture, video, email, voice-over PowerPoint, online editing and feedback, audio/phone call, and evaluation as predictors. From the results of logistic regression analysis, lecture, video, email, voice-over PowerPoint, online editing and feedback, audio/phone calls, and evaluation were not significant predictors for increases in participants' attitudes toward learning when learner-to-instructor interaction was provided in online learning.

Table 31
Technology as a Predictor for Agreement with Increased Learning when Learner-to-Instructor Interaction was Provided in an Online Course as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Construct		B	S.E.	Wald	P	Exp(B)
Step 1	Lecture	0.664	0.452	2.156	0.142	1.942
	Video	0.191	0.436	0.193	0.660	1.211
	Email	-0.431	0.602	0.514	0.474	0.650
	Voice-over PowerPoint	0.727	0.542	1.801	0.180	2.069
	Online editing and feedback	-0.048	0.508	0.009	0.924	0.953
	Audio/phone calls	0.053	0.538	0.010	0.922	1.054
	Evaluation	0.499	0.509	0.962	0.327	1.648
	(Constant)	-0.830	1.812	0.210	0.647	0.436

Note. Variable(s) entered on step 1: (Constant), Lecture, Video, Email, Voice over PowerPoint, Online editing and feedback, Audio/phone call, Evaluation. Nagelkerke's $R^2 = 0.205$.

When Learner-to-Course Content Interaction was Provided in an Online Course

As Table 32 shows, a logistic regression analysis was conducted to predict participants' attitudes toward satisfaction with the online learning experience when learner-to-course content interaction was provided in online learning, using

text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercises, podcasting, and collaborative documents as predictors.

Nagelkerke's R^2 is 0.276. The Wald criterion demonstrated that support materials ($p = 0.05$), online practice exercises ($p = 0.03$), and podcasting ($p = 0.05$) made a significant contribution to prediction. Text/textbooks, case studies, PowerPoint, interactive video, and collaborative were not significant predictors. Exp (B) value indicates that when learners' preference for using support materials to enhance learner-to-course content interaction is raised by one unit, the odds ratio is 0.2 times more likely to have higher agreement with satisfaction of online learning experiences when learner-to-course content interaction was provided than learners who do not use support materials. When learners' preference for using online practice exercises to enhance learner-to-course content interaction is raised by one unit, the odds ratio is 3.34 times more likely to have higher agreement with the satisfaction of online learning experiences when learner-to-course content interaction is provided than learners who don't use online practice exercises. When learners' preference for using podcasting to enhance learner-to-course content interaction is raised by one unit, the odds ratio is 0.3 times more likely to have higher agreement with the satisfaction of online learning experiences when learner-to-course content interaction is provided than learners who do not use podcasting.

Learners who prefer to use support materials and podcasting to enhance learner-to-course content interaction are 0.2 and 0.3 times more likely to have higher satisfaction with their online learning experiences than others. Learners who prefer to use online

practice exercises to enhance learner-to-course content interaction are 3.34 times more likely to have higher satisfaction with their online learning experiences than others.

Table 32
Technology as a Predictor for Satisfaction with an Online Learning Experience When Learner-to-Course Content Interaction was Provided in an Online Course as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Construct		B	S.E.	Wald	P	Exp(B)
Step 1	Text / Textbooks	-0.037	0.495	0.005	0.941	0.964
	Support materials	-1.627	0.823	3.913	0.048*	0.196
	Case studies	0.335	0.460	0.530	0.467	1.398
	PowerPoint	0.873	0.526	2.756	0.097	2.394
	Interactive video	-0.193	0.618	0.098	0.755	0.824
	Online practice exercises	1.207	0.539	5.015	0.025*	3.344
	Podcasting	-1.244	0.622	4.008	0.045*	0.288
	Collaborative documents	-0.037	0.473	0.006	0.938	0.964
	(Constant)	6.732	3.288	4.191	0.041*	838.841

Note. Variable(s) entered on step 1: (Constant), Text/Textbooks, Support materials, Case studies, PowerPoint, Interactive video, Online practice exercises, Podcasting, Collaborative documents. Nagelkerke's $R^2 = 0.276$.

As Table 33 shows, a logistic regression analysis was conducted to predict participants' attitudes toward quality of the online learning experience when learner-to-course content interaction was provided in online learning, using text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercises, podcasting, and collaborative documents as predictors.

Nagelkerke's R^2 is 0.213. The Wald criterion demonstrated that case studies (p= 0.02) and podcasting (p = 0.04) made a significant contribution to prediction. Text/textbooks, support materials, PowerPoint, interactive video, online practice

exercises, and collaborative documents were not significant predictors. Exp (B) value indicates that when learners' preference of using case studies to enhance learner-to-course content interaction is raised by one unit, the odds ratio is 2.65 times more likely to have higher agreement with the quality of online learning experiences when learner-to-course content interaction was provided than learners who do not use case studies. When learners' preference for using podcasting to enhance learner-to-course content interaction is raised by one unit, the odds ratio is 0.38 times more likely to have higher agreement with the quality of online learning experiences when learner-to-course content interaction was provided than learners who do not use podcasting.

Learners who prefer to use case studies to enhance learner-to-course content interaction are 2.65 times more likely to have a positive attitude toward the quality of their online learning experiences than others. However, learners who prefer to use podcasting to enhance learner-to-learner interaction are only 0.38 times more likely to have a positive attitude toward the quality of their online learning experiences than others.

Table 33

Technology as a Predictor for Quality of an Online Learning Experience When Learner-to-Course Content Interaction was Provided in an Online Course as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Construct		B	S.E.	Wald	P	Exp(B)
Step 1	Text / Textbooks	-0.032	0.399	0.006	0.936	0.969
	Support materials	-0.907	0.590	2.363	0.124	0.404
	Case studies	0.974	0.400	5.937	0.015*	2.648
	PowerPoint	0.632	0.423	2.231	0.135	1.881
	Interactive video	0.140	0.446	0.098	0.754	1.150
	Online practice exercises	0.398	0.445	0.803	0.370	1.490
	Podcasting	-0.957	0.472	4.108	0.043*	0.384
	Collaborative documents	-0.059	0.394	0.022	0.882	0.943
	(Constant)	2.915	1.992	2.142	0.143	18.443

Note. Variable(s) entered on step 1: (Constant), Text/Textbooks, Support materials, Case studies, PowerPoint, Interactive video, Online practice exercises, Podcasting, Collaborative documents. Nagelkerke's R^2 = 0.213.

As Table 34 shows, a logistic regression analysis was conducted to predict participants' attitudes toward increases in learning when learner-to-course content interaction was provided in an online course, using text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercises, podcasting, and collaborative documents as predictors.

Nagelkerke's R^2 is 0.179. The Wald criterion demonstrated that only case studies made a significant contribution to prediction (p = 0.01). Text/textbooks, support materials, PowerPoint, interactive video, online practice exercises, podcasting, and collaborative documents were not significant predictors. Exp (B) value indicates that when learners' preference for using case studies to enhance learner-to-course content interaction is raised by one unit, the odds ratio is 3.05 times more likely to have higher

agreement with increased learning in the online course when learner-to-course content interaction was provided than learners who do not use case studies. Learners who prefer to use case studies to enhance the learner-to-course content interaction are 3.05 times likely to have a positive attitude toward learning increases in the online course than others.

Table 34
Technology as a Predictor for Agreement with the Increased Learning When Learner-to-Course Content Interaction was Provided in an Online Course as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Construct		B	S.E.	Wald	P	Exp(B)
Step 1	Text / Textbooks	-0.425	0.481	0.780	0.377	0.654
	Support materials	-0.174	0.587	0.088	0.766	0.840
	Case studies	1.113	0.429	6.745	0.009*	3.045
	PowerPoint	0.025	0.501	0.002	0.961	1.025
	Interactive video	0.246	0.445	0.305	0.581	1.279
	Online practice exercises	0.108	0.485	0.050	0.824	1.114
	Podcasting	-0.921	0.472	3.805	0.051	0.398
	Collaborative documents	0.071	0.414	0.029	0.864	1.074
	(Constant)	3.593	2.185	2.705	0.100	36.359

Note. Variable(s) entered on step 1: (Constant), Text/Textbooks, Support materials, Case studies, PowerPoint, Interactive video, Online practice exercises, Podcasting, Collaborative documents. Nagelkerke's $R^2 = 0.179$.

When Learner-to-Course Technology Interaction was Provided in the Online Course

As Table 35 shows, a logistic regression analysis was conducted to predict participants' attitudes toward the satisfaction with their online learning experience when learner-to-course technology interaction was provided in online learning, using online

tutorials, getting help online, online instructions for downloading plugins, electronic libraries, apps, file management systems, and search engines as predictors.

Nagelkerke's R^2 is 0.12. The Wald criterion demonstrated that only apps made a significant contribution to prediction ($p = 0.01$). Online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, file management systems, and search engines were not significant predictors. Exp (B) value indicates that when learners' preference of using apps to enhance learner-to-course technology interaction is raised by one unit, the odds ratio is 1.55 times more likely to have higher satisfaction of an online learning experience when learner-to-course technology interaction was provided than learners who do not use apps. Learners who prefer to use apps to enhance the learner-to-course technology interaction are 1.55 times likely to have the higher satisfaction toward their online learning experiences than others.

Table 35
Technology as a Predictor for Satisfaction of an Online Learning Experiences When Learner-to-Course Technology Interaction was Provided in an Online Course as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Construct		B	S.E.	Wald	P	Exp(B)
Step 1	Online tutorials	0.073	0.183	0.161	0.688	1.076
	Getting help online	0.158	0.174	0.829	0.362	1.172
	Online instructions for downloading plugins	0.210	0.176	1.420	0.233	1.234
	Electronic libraries	0.059	0.158	0.138	0.710	1.061

Note. Variable(s) entered on step 1: (Constant), Online tutorials, Getting help online, Online instructions for downloading plugins, Electronic libraries, Apps, File management systems, Search engines. Nagelkerke's $R^2 = 0.119$.

Table 35 Continued

Construct		B	S.E.	Wald	P	Exp(B)
Step 1	Apps	0.435	0.151	8.250	0.004*	1.545
	File management systems	-0.260	0.181	2.053	0.152	0.771
	Search engines	0.100	0.167	0.359	0.549	1.105
	(Constant)	-1.492	0.753	3.924	0.048*	0.225

Note. Variable(s) entered on step 1: (Constant), Online tutorials, Getting help online, Online instructions for downloading plugins, Electronic libraries, Apps, File management systems, Search engines. Nagelkerke's $R^2 = 0.119$.

As Table 36 shows, a logistic regression analysis was conducted to predict participants' attitudes toward the quality of their online learning experience when learner-to-course technology interactions were provided, using online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, apps, file management systems, and search engines as predictors.

Nagelkerke's R^2 is 0.12. The Wald criterion demonstrated that only apps made a significant contribution to prediction ($p = 0.02$). Online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, file management systems, and search engines were not significant predictors. Exp (B) value indicates that when learners' preference for using apps to enhance learner-to-course technology interaction is raised by one unit, the odds ratio is 1.45 times more likely to have higher agreement with the quality of online learning experiences when learner-to-course technology interaction was provided than learners who do not use apps. Learners who prefer to use apps to enhance learner-to-course technology interaction are 1.45 times likely to have a positive attitude toward quality of their online learning experiences than others.

Table 36

Technology as a Predictor for Quality of an Online Learning Experiences When Learner-to-Course Technology Interaction was Provided in an Online Course as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Construct		B	S.E.	Wald	P	Exp(B)
Step 1	Online tutorials	0.144	0.186	0.599	0.439	1.155
	Getting help online	0.241	0.180	1.792	0.181	1.273
	Online instructions for downloading plugins	0.198	0.183	1.178	0.278	1.220
	Electronic libraries	-0.198	0.164	1.468	0.226	0.820
	Apps	0.371	0.155	5.710	0.017*	1.449
	File management systems	0.012	0.181	0.004	0.947	1.012
	Search engines	0.090	0.169	0.285	0.594	1.094
	(Constant)	-1.778	0.772	5.310	0.021*	0.169

Note. Variable(s) entered on step 1: (Constant), Online tutorials, Getting help online, Online instructions for downloading plugins, Electronic libraries, Apps, File management systems, Search engines. Nagelkerke's $R^2 = 0.122$.

As Table 37 shows, a logistic regression analysis was conducted to predict participants' attitudes toward increased learning when learner-to-course technology interactions were provided in online learning, using online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, apps, file management systems, and search engines as predictors.

Nagelkerke's R^2 is 0.11. The Wald criterion demonstrated that only apps made a significant contribution to prediction ($p = 0.02$). Online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, file management systems, and search engines were not significant predictors. Exp (B) value indicates that when learners' preference for using apps to enhance learner-to-course technology interaction is raised by one unit, the odds ratio is 1.46 times more likely to have higher

agreement with increased learning in the online course when learner-to-course technology interaction was provided than learners who do not use apps. Learners who prefer to use apps to enhance learner-to-course technology interaction are 1.46 times more likely to have a positive attitude toward increased learning in online courses than others.

Table 37
Technology as a Predictor for Agreement with Increased Learning When Learner-to-Course Technology Interaction was Provided in an Online Course as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Construct		B	S.E.	Wald	P	Exp(B)
Step 1	Online tutorials	0.012	0.189	0.004	0.950	1.012
	Getting help online	0.347	0.183	3.599	0.058	1.415
	Online instructions for ownloading plugins	0.201	0.187	1.150	0.284	1.222
	Electronic libraries	-0.289	0.167	2.998	0.083	0.749
	Apps	0.376	0.158	5.692	0.017*	1.457
	File management systems	0.083	0.182	0.208	0.648	1.087
	Search engines	-0.032	0.172	0.035	0.852	0.969
	(Constant)	-1.027	0.766	1.798	0.180	0.358

Note. Variable(s) entered on step 1: (Constant), Online tutorials, Getting help online, Online instructions for downloading plugins, Electronic libraries, Apps, File management systems, Search engines. Nagelkerke's $R^2 = 0.111$.

Findings Related to Objective Seven

The seventh objective was to determine and describe participants' preferences for technologies used to enhance interactions for online learning. Thirty-one different types of technologies were used to measure participants' agreement with the question: "Is the use of the following technology an effective means for enhancing interactions with other

learners, the instructor, the course content, or the course technology?" The respondents were able to choose multiple responses for each given technology.

Table 38 shows that the participants reported the most useful technologies to enhance interaction with other learners to be Google Docs (*f* = 277, 76.5%), Facebook (*f* = 247, 68.2%), email (*f* = 237, 65.5%), threaded discussions (*f* = 216, 59.7%), and audio/phone calls (*f* = 204, 56.4%). The least effective technologies to enhance interaction with other learners were Pinterest (*f* = 67, 18.5%), Viber (*f* = 52, 14.4%), voice-over PowerPoint (*f* = 51, 14.1%), Line (*f* = 40, 11.0%), and Quip (*f* = 38, 10.5%).

Table 38
Technologies' Enhancement of Interaction with Other Learners as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

	With Other Learners	
Technology	*f*	%
Google Docs	277	76.5
Facebook	247	68.2
Email	237	65.5
Threaded discussions	216	59.7
Audio/phone call	204	56.4
Lecture	169	46.7
Snapchat	153	42.3
Dropbox	152	42.0
Skype	141	39.0
Instagram	139	38.4
Role play/simulations	139	38.4
Google+	138	38.1
Getting help online	129	35.6
Twitter	123	34.0
Instructor announcements	123	34.0
Case studies	113	31.2

Table 38 Continued

Technology	With Other Learners	
	f	%
Online calendar	112	30.9
PowerPoint	105	29.0
LinkedIn	102	28.2
Worksheets	102	28.2
Text/Textbook	101	27.9
Online quizzes	92	25.4
Blogger	86	23.8
YouTube	85	23.5
WhatsApp	84	23.2
Online tutorials	80	22.1
Pinterest	67	18.5
Viber	52	14.4
Voice-over PowerPoint	51	14.1
Line	40	11.0
Quip	38	10.5

Table 39 shows that the most useful technologies to enhance interaction with the instructor, as reported by participants, were email (*f* = 316, 87.3%), lecture (*f* = 306, 84.5%), instructor announcements (*f* = 290, 80.1%), PowerPoint (*f* = 235, 64.9%), online calendar (*f* = 170, 47.0%), and voice-over PowerPoint (*f* = 160, 44.2%). The least effective technologies to enhance interaction with the instructor were reported as Quip (*f* = 22, 6.1%), Whats App (*f* = 22, 6.1%), Pinterest (*f* = 17, 4.7%), Viber (*f* = 14, 3.9%), and Snapchat (*f* = 10, 2.8%).

Table 39
Technologies' Enhancement of Interaction with the Instructor as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

	With the Instructor	
Technology	*f*	%
Email	316	87.3
Lecture	306	84.5
Instructor announcements	290	80.1
PowerPoint	235	64.9
Online calendar	170	47.0
Voice over PowerPoint	160	44.2
Dropbox	158	43.6
Getting help online	158	43.6
Threaded discussions	158	43.6
Case studies	149	41.2
Google Docs	147	40.6
Audio/phone call	139	38.4
Online quizzes	131	36.2
Online tutorials	126	34.8
Worksheets	123	34.0
Text/Textbook	121	33.4
Role play/Simulations	96	26.5
LinkedIn	89	24.6
Facebook	88	24.3
Google+	86	23.8
YouTube	84	23.2
Skype	79	21.8
Blogger	49	13.5
Line	34	9.4
Instagram	26	7.2
Quip	22	6.1
Whats App	22	6.1
Pinterest	17	4.7
Viber	14	3.9
Snapchat	10	2.8

Table 40 shows that the most useful technologies to enhance interaction with the course content, as reported by participants, to be text/textbook (*f* = 276, 76.2%),

PowerPoint (*f* = 272, 75.1%), online quizzes (*f* = 265, 73.2%), lecture (*f* = 253, 69.9%), case studies (*f* = 239, 66%), and online tutorials (*f* = 229, 63.3%). The least effective technologies to enhance interaction with the course content were reported as WhatsApp (f = 24, 6.6%), Instagram (f = 22, 6.1%), Twitter (f = 19, 5.2%), Snapchat (f = 15, 4.1%), and Viber (f = 10, 2.8%).

Table 40
Technologies' Enhancement of Interaction with Course Content as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

	With the Course Content	
Technology	*f*	%
Text/Textbook	276	76.2
PowerPoint	272	75.1
Online quizzes	265	73.2
Lecture	253	69.9
Case studies	239	66
Online tutorials	229	63.3
Getting help online	214	59.1
Worksheets	214	59.1
YouTube	203	56.1
Google Docs	196	54.1
Instructor announcements	189	52.2
Voice-over PowerPoint	188	51.9
Online calendar	187	51.7
Role play/Simulations	150	41.4
Email	123	34
Dropbox	120	33.1
Google+	103	28.5
Blogger	86	23.8
Audio/phone call	64	17.7
Facebook	62	17.1
Skype	33	9.1

Table 40 Continued

Technology	With the Course Content	
	f	%
Line	29	8.0
LinkedIn	28	7.7
Pinterest	25	6.9
Quip	25	6.9
WhatsApp	24	6.6
Instagram	22	6.1
Twitter	19	5.2
Snapchat	15	4.1
Viber	10	2.8

Table 41 shows that the most useful technologies to enhance interaction with course technology, as reported by participants, was getting help online (*f* = 185, 51.1%), online tutorials (*f* = 168, 46.4%), YouTube (*f* = 159, 43.9%), online quizzes (*f* = 153, 42.3%), and PowerPoint (*f* = 150, 41.4%). The least effective technologies to enhance interaction with the course technology were reported as Quip (*f* = 49, 13.5%), WhatsApp (*f* = 48, 13.3%), worksheets (*f* = 47, 13.0%), Viber (*f* = 40, 11.0%), and Line (*f* = 37, 10.2%).

Table 41
Enhancement for Course Technologies as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	With the Course Technology	
	f	%
Getting help online	185	51.1
Online tutorials	168	46.4
YouTube	159	43.9
Online quizzes	153	42.3

Table 41 Continued

Technology	With the Course Technology	
	f	%
Google docs	141	39.0
Online calendar	137	37.8
Dropbox	116	32.0
Google +	110	30.4
Voice over PowerPoint	101	27.9
Email	99	27.3
Instructor announcements	99	27.3
Blogger	91	25.1
Facebook	82	22.7
Threaded discussions	79	21.8
Skype	76	21.0
LinkedIn	69	19.1
Audio/ phone call	67	18.5
Lecture	66	18.2
Twitter	63	17.4
Case studies	62	17.1
Text / Textbook	59	16.3
Role play/ Simulations	59	16.3
Instagram	58	16.0
Pinterest	54	14.9
Snapchat	51	14.1
Quip	49	13.5
WhatsApp	48	13.3
Worksheets	47	13.0
Viber	40	11.0
Line	37	10.2

Findings Related to Objective Eight

The eighth objective was to examine the relationship between participants' selected personal characteristics and their preference for technologies to enhance interactions in online learning.

Differences between Genders

To examine the relationship between participants' gender and their preferences toward technology for enhancing interactions in online courses with other learners, with the instructor, with course content, and with course technology, the participants were divided into two groups. The two groups were males and females.

An independent-samples t-test was conducted to compare participants' preferences for technology to enhance learner-to-learner interaction between males and females, as shown in Table 42. There was no significant difference between males and females with preferences for email, audio/phone calls, social media, instant messaging, blogging, and collaborative documents to enhance learner-to-learner interaction. These results suggest that gender may not be a factor that influences participants' preferences for technology to enhance learner-to-learner interaction.

Table 42
Differences between Genders in Preferences toward Technologies to Enhance Learner-to-Learner Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Email	105	3.19	1.066	0.357	0.721
	257	3.14	1.148		
Audio/phone call	105	3.03	1.033	0.998	0.319
	257	2.91	1.017		
Social Medias	105	3.32	1.156	-1.863	0.063
	257	3.56	1.070		
Instant messaging	105	3.80	1.041	-0.288	0.774
	257	3.84	1.120		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Male: $n = 105$; Female: $n = 257$.

Table 42 Continued

Technology	*n*	*Mean*	*SD*	*t*	*p*
Blogging	105	2.41	0.927	-1.927	0.055
	257	2.62	0.941		
Collaborative documents	105	3.96	0.940	-0.894	0.372
	257	4.07	1.084		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Male: $n = 105$; Female: $n = 257$.

An independent-samples t-test was conducted to compare participants' preferences for technology to enhance learner-to-instructor interaction between males and females, as shown in Table 43. There was a significant difference in the preference toward lecture between males ($M = 4.44$, $SD = 0.553$) and females ($M = 4.22$, $SD = 0.927$); t (360) = 2.274, $p = 0.024$. There was a significant difference in the preference toward online editing and feedback between males ($M = 3.51$, $SD = 0.942$) and females ($M = 3.79$, $SD = 0.953$); t (360) = -2.505, $p = 0.013$. However, there was no significant difference between males and females in their preferences for video, email, voice-over PowerPoint, audio/phone calls, and evaluation to enhance learner-to-instructor interaction.

These results suggest that males, more than females, prefer to use lecture to enhance learner-to-instructor interaction in their online learning. Additionally, females have a greater preference than males for online editing and feedback as an effective technology to enhance learner-to-instructor interaction in their online learning.

Table 43
Differences between Genders in Preferences toward Technologies to Enhance Learner-to-Instructor Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Lecture	105	4.44	0.553	2.274	0.024*
	257	4.22	0.927		
Video	105	3.61	0.904	1.095	0.274
	257	3.48	1.039		
Email	105	3.89	0.812	-0.650	0.516
	257	3.95	0.930		
Voice over PowerPoint	105	3.26	1.056	0.330	0.742
	257	3.21	1.158		
Online editing and feedback	105	3.51	0.942	-2.505	0.013*
	257	3.79	0.953		
Audio/phone call	105	2.91	0.972	-0.142	0.887
	257	2.93	0.941		
Evaluation	105	3.65	0.940	-0.234	0.815
	257	3.67	0.941		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Male: $n = 105$; Female: $n = 257$.

An independent-samples t-test was conducted to compare participants' preferences for technology to enhance learner-to-course content interaction between males and females, as shown in Table 44. There was a significant difference in the preferences toward podcasting between males ($M = 2.86$, $SD = 0.893$) and females ($M = 3.09$, $SD = 1.012$); $t\ (360) = -2.015$, $p = 0.045$. There was no significant difference between males and females in their preferences for text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercise, and collaborative documents to enhance learner-to-course content interaction.

These results suggest that females have a greater preference than males for podcasting as a way to enhance learner-to-course content interaction in their online learning.

Table 44
Differences between Genders in Preferences toward Technologies to Enhance Learner-to-Course Content Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Text / Textbooks	105	3.68	1.079	0.706	0.481
	257	3.59	1.020		
Support materials	105	3.97	0.778	0.447	0.655
	257	3.93	0.913		
Case studies	105	3.89	0.923	1.437	0.152
	257	3.73	0.928		
PowerPoint	105	4.15	0.718	-0.116	0.908
	257	4.16	0.864		
Interactive video	105	3.69	0.902	-1.810	0.071
	257	3.89	0.984		
Online practice exercises	105	4.04	0.771	-1.190	0.235
	257	4.15	0.846		
Podcasting	105	2.86	0.893	-2.015	0.045*
	257	3.09	1.012		
Collaborative documents	105	3.77	0.943	-1.709	0.088
	257	3.95	0.909		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Male: $n = 105$; Female: $n = 257$.

An independent-samples t-test was conducted to compare male and female participants' preferences for technology that enhances learner-to-course technology interaction, as shown in Table 45. There was a significant difference in the preferences for file management systems between male ($M = 3.80$, $SD = 0.945$) and female ($M =$

4.02, *SD* = 0.873); *t* (360) = -2.119, *p* = 0.035. There was no significant difference between males and females in their preferences for online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, apps, and search engines to enhance learner-to-course content interaction.

These results suggest that females have greater preference than males to use file management systems to enhance learner-to-course technology interaction in their online learning.

Table 45
Differences between Genders in Preferences toward Technologies to Enhance Learner-to-Course Technology Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Online tutorials	105	3.72	0.849	-0.426	0.673
	257	3.77	0.991		
Getting help online	105	3.50	0.932	-0.638	0.524
	257	3.58	1.047		
Online instructions for downloading plugins	105	3.36	0.992	-0.236	0.813
	257	3.39	0.994		
Electronic libraries	105	3.56	0.960	0.047	0.963
	257	3.56	1.041		
Apps	105	3.48	1.057	-1.850	0.065
	257	3.70	1.016		
File management systems	105	3.80	0.945	-2.119	0.035*
	257	4.02	0.873		
Search engines	105	4.31	0.824	-0.613	0.540
	257	4.37	0.839		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Male: *n* = 105; Female: *n* = 257.

Differences between Upper and Lower Classifications

To examine the relationship between participants' classification and their preferences for technology to enhance interactions with other learners, with the instructor, with course content, and with course technology in online courses, participants were divided into two groups by classification: upper classification and lower classification. The upper classification included participants who were juniors or seniors. The lower classification included participants who were freshman or sophomores.

An independent-samples t-test was conducted to compare participants' preferences for technology to enhance learner-to-learner interaction between upper and lower classifications, as shown in Table 46. There was no significant difference between upper classification students and lower classification students in their preferences for email, audio/phone calls, social media, instant messaging, blogging, and collaborative documents to enhance learner-to-learner interaction. These results suggest that students' classification may be not a factor that influences participants' preferences toward technology to enhance learner-to-learner interaction.

Table 46
Differences between Upper Classification and Lower Classification Participants' Preferences toward Technologies that Enhance Learner-to-Learner Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Email	239	3.21	1.108	1.321	0.187
	123	3.05	1.151		
Audio/phone call	239	2.99	1.023	1.109	0.268
	123	2.86	1.019		
Social Medias	239	3.51	1.100	0.452	0.652
	123	3.46	1.103		
Instant messaging	239	3.84	1.054	0.262	0.793
	123	3.80	1.178		
Blogging	239	2.55	0.942	-0.101	0.872
	123	2.57	0.942		
Collaborative documents	239	4.06	1.000	0.611	0.541
	123	3.99	1.127		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Senior classifications: $n = 239$; Low classifications: $n = 123$.

An independent-samples t-test was conducted to compare participants' preferences for technology that enhances learner-to-instructor interaction between upper and lower classifications, as shown in Table 47. There was no significant difference between upper classification students and lower classification students in their preferences for lecture, video, email, voice-over PowerPoint, online editing and feedback, audio/phone calls, and evaluation to enhance learner-to-instructor interaction. These results suggest that students' classification may be not a factor that influences participants' preferences for technology that enhances learner-to-instructor interaction.

Table 47
Differences between Upper Classification and Lower Classification Participants' Preferences for Technologies to Enhance Learner-to-Instructor Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Lecture	239	4.28	0.842	0.087	0.931
	123	4.28	0.843		
Video	239	3.51	1.012	-0.235	0.815
	123	3.54	0.986		
Email	239	3.97	0.850	1.219	0.224
	123	3.85	0.981		
Voice over PowerPoint	239	3.26	1.148	0.773	0.440
	123	3.16	1.089		
Online editing and feedback	239	3.69	0.967	-0.426	0.670
	123	3.74	0.939		
Audio/phone call	239	2.92	0.971	-0.254	0.800
	123	2.94	0.908		
Evaluation	239	3.64	0.932	-0.604	0.547
	123	3.71	0.956		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Senior classification: *n* = 239; Low classification: *n* = 123.

An independent-samples t-test was conducted to compare participants' preferences for technology that enhances learner-to-course content interaction between upper and lower classifications, as shown in Table 48. There was no significant difference between upper classification students and lower classification students in their preferences for text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercises, podcasting, and collaborative documents to enhance learner-to-course content interaction. These results suggest that students' classification may be not a factor that influences participants' preferences for technology to enhance learner-to-course content interaction.

Table 48
Differences between Upper Classification and Lower Classification Participants' Preferences for Technologies that Enhance Learner-to-Course Content Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Text / Textbooks	239	3.62	1.054	-0.025	0.980
	123	3.62	1.004		
Support materials	239	3.91	0.898	-0.947	0.344
	123	4.00	0.830		
Case studies	239	3.84	0.912	1.857	0.064
	123	3.65	0.949		
PowerPoint	239	4.14	0.841	-0.713	0.476
	123	4.20	0.789		
Interactive video	239	3.85	0.957	0.683	0.495
	123	3.78	0.980		
Online practice exercises	239	4.11	0.815	-0.187	0.852
	123	4.13	0.849		
Podcasting	239	3.07	1.027	1.286	0.199
	123	2.93	0.889		
Collaborative documents	239	3.94	0.915	1.177	0.240
	123	3.82	0.932		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Senior grades: $n = 239$; Low grades: $n = 123$.

An independent-samples t-test was conducted to compare participants' preferences for technology that enhances learner-to-course technology interaction between upper and lower classifications, as shown in Table 49. There was no significant difference between upper classification students and lower classification students in their preferences for online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, apps, file management systems, and search engines to enhance learner-to-course technology interaction. These results suggest that students'

classification may be not an influencing factor for participants' preferences toward technology to enhance learner-to-course technology interaction.

Table 49
Differences between Upper Classification and Lower Classification Participants in Preferences for Technologies to Enhance Learner-to-Course Technology Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Online tutorials	239	3.77	0.950	0.245	0.807
	123	3.74	0.957		
Getting help online	239	3.53	1.020	-0.696	0.487
	123	3.61	1.005		
Online instructions for downloading plugins	239	3.40	0.986	0.546	0.585
	123	3.34	1.007		
Electronic libraries	239	3.58	1.021	0.614	0.539
	123	3.51	1.011		
Apps	239	3.61	1.022	-0.558	0.577
	123	3.67	1.052		
File management systems	239	3.97	0.862	0.440	0.660
	123	3.93	0.968		
Search engines	239	4.31	0.867	-1.623	0.105
	123	4.46	0.760		

Note. * $p < 0.05$. Scale: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Upper classification (Juniors and Seniors): $n = 239$; Lower classification (Freshman and Sophomores): $n = 123$.

Differences between Non-science and Science Majors

To examine the relationship between participants' majors and their preferences for technology that enhances interactions with other learners, with the instructor, with course content, and with course technology in online courses, participants were divided into two groups by major. The two groups were non-science majors and science majors.

The non-science majors group included participants whose majors were in the following departments: Agricultural Economics; Agricultural Leadership, Education, and Communications; and Recreation, Parks and Tourism Science. The science majors group included participants whose majors were in the following departments: Animal Science, Biochemistry and Biophysics, Biological and Agricultural Engineering, Ecosystem Science and Management, Entomology, Horticultural Sciences, Nutrition and Food Science, Plant Pathology and Microbiology, Poultry Science, Soil and Crop Sciences, and Wildlife and Fisheries Sciences.

An independent-samples t-test was conducted to compare participants' preferences for technology that enhances learner-to-learner interaction between non-science majors and science majors, as shown in Table 50. There was a significant difference in the preferences for instant messaging between non-science majors (M = 3.69, SD = 1.169) and science majors (M = 3.92, SD = 1.036); t (360) = -2.001, p = 0.046. There was also a significant difference in the preferences for collaborative documents between non-science majors (M = 3.78, SD = 1.121) and science majors (M = 4.22, SD = 0.949); t (360) = -4.049, p = 0.000. There was no significant difference between non-science majors and science majors in their preferences for email, audio/phone calls, social media, and blogging to enhance learner-to-learner interaction. These results suggest that science majors have a greater preference than non-science majors to use instant messaging and collaborative documents to enhance learner-to-learner interaction in online learning.

Table 50
Differences between Non-Science and Science Major Participants' Preferences for Technologies that Enhance Learner-to-Learner Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Email	147	3.09	1.158	-0.966	0.335
	215	3.20	1.100		
Audio/phone call	147	2.99	1.044	0.745	0.456
	215	2.91	1.008		
Social Medias	147	3.41	1.139	-1.196	0.232
	215	3.55	1.070		
Instant messaging	147	3.69	1.169	-2.001	0.046*
	215	3.92	1.036		
Blogging	147	2.66	1.003	1.708	0.088
	215	2.49	0.891		
Collaborative documents	147	3.78	1.121	-4.049	0.001*
	215	4.22	0.949		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Non-science majors: n = 147; Science majors: n = 215.

An independent-samples t-test was conducted to compare participants' preferences for technology to enhance learner-to-instructor interaction between non-science majors and science majors, as shown in Table 51. There was a significant difference in the preference for lecture between non-science majors (M = 4.17, SD = 0.909) and science majors (M = 4.36, SD = 0.784); t (360) = -2.100, p = 0.036. There was also a significant difference in the preference for audio/phone calls between non-science majors (M = 3.05, SD = 2.84) and science majors (M = 2.84, SD = 0.915); t (360) = 2.150, p = 0.032. There was no significant difference between non-science majors and science majors in their preferences for video, email, voice-over PowerPoint, online editing and feedback, and evaluation to enhance learner-to-instructor interaction.

These results suggest that students in the science majors have a greater preference than students in the non-science majors to use lecture to enhance learner-to-instructor interaction in online learning; students in the non-science majors have greater preference than students in the science majors for audio/phone calls to enhance learner-to-instructor interaction in online learning.

Table 51
Differences between Non-Science and Science Major Participants' Preferences toward Technologies to Enhance Learner-to-Instructor Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Lecture	147	4.17	0.909	-2.100	0.036*
	215	4.36	0.784		
Video	147	3.48	1.056	-0.570	0.569
	215	3.54	0.965		
Email	147	3.86	0.911	-1.224	0.222
	215	3.98	0.886		
Voice over PowerPoint	147	3.10	1.169	-1.741	0.083
	215	3.31	1.094		
Online editing and feedback	147	3.65	1.011	-0.935	0.350
	215	3.75	0.918		
Audio/phone call	147	3.05	0.985	2.150	0.032*
	215	2.84	0.915		
Evaluation	147	3.67	0.945	0.129	0.897
	215	3.66	0.938		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Non-science majors: *n* = 147; Science majors: *n* = 215.

An independent-samples t-test was conducted to compare participants who were non-science and science majors in regard to preferences for technology that enhances learner-to-course content interaction, as shown in Table 52. There was a significant

difference in the preference for text/textbooks between non-science majors (*M* =3.47, *SD* =1.036) and science majors (*M* = 3.72, *SD* =1.027); *t* (360) = -2.239, *p* = 0.026. There was a second significant difference in the preference for support materials between non-science majors (*M* =3.73, *SD* = 0.967) and science majors (*M* = 4.08, *SD* =0.778); *t* (360) = -3.741, *p* = 0.000. There was a third significant difference in the preference for case studies between non-science majors (*M* =3.54, *SD* = 0.967) and science majors (*M* = 3.93, *SD* = 0.868); *t* (360) = -4.015, *p* = 0.000. There was a fourth significant difference in the preference for PowerPoint between non-science majors (*M* = 4.00, *SD* = 0.922) and science majors (*M* = 4.27, *SD* =0.731); *t* (360) = -3.098, *p* = 0.002. There was a fifth significant difference in the preference for interactive video between non-science majors (*M* = 3.65, *SD* = 1.108) and science majors (*M* = 3.95, *SD* = 0.833); *t* (360) = -2.816, *p* = 0.004. There was a sixth significant difference in the preference for online practice exercises between non-science majors (*M* =3.95, *SD* = 0.909) and science majors (*M* = 4.23, *SD* =0.744); *t* (360) = -3.213, *p* = 0.001. Finally, there was a seventh significant difference in the preference for collaborative documents between non-science majors (*M* =3.71, *SD* =0.958) and science majors (*M* = 4.03, *SD* =0.875); *t* (360) = -3.222, *p* = 0.001. There was no significant difference between non-science majors and science majors in preferences for podcasting to enhance learner-to-course content interaction.

These results suggest that students in the science majors have a greater preference than students in the non-science majors for the use of text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercise, and

collaborative documents to enhance learner-to-course content interaction in online learning.

Table 52
Differences between Non-Science and Science Major Participants' Preferences toward Technologies to Enhance Learner-to-Course Content Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Text / Textbooks	147	3.47	1.036	-2.239	0.026*
	215	3.72	1.027		
Support materials	147	3.73	0.967	-3.741	0.000*
	215	4.08	0.778		
Case studies	147	3.54	0.967	-4.015	0.000*
	215	3.93	0.868		
PowerPoint	147	4.00	0.922	-3.098	0.002*
	215	4.27	0.731		
Interactive video	147	3.65	1.108	-2.816	0.004*
	215	3.95	0.833		
Online practice exercises	147	3.95	0.909	-3.213	0.001*
	215	4.23	0.744		
Podcasting	147	2.97	0.996	-0.853	0.394
	215	3.06	0.975		
Collaborative documents	147	3.71	0.958	-3.222	0.001*
	215	4.03	0.875		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Non-science majors: *n* = 147; Science majors: *n* = 215.

An independent-samples t-test was conducted to compare non-science major and science major participants' preferences for technology that can enhance learner-to-course technology interaction, as shown in Table 53. There was no significant difference between non-science majors and science majors in their preferences for online tutorials,

getting help online, online instructions for downloading plugins, electronic libraries, apps, file management systems, and search engines to enhance learner-to-course technology interaction. These results suggest that major may be not a factor that influences participants' preferences for technology that enhances learner-to-learner interaction.

Table 53
Differences between Non-Science and Science Major Participants' Preferences toward Technologies to Enhance Learner-to-Course Technology Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Online tutorials	147	3.66	1.063	-1.609	0.109
	215	3.82	0.863		
Getting help online	147	3.47	1.081	-1.377	0.170
	215	3.62	0.964		
Online instructions for downloading plugins	147	3.35	1.005	-0.435	0.664
	215	3.40	0.985		
Electronic libraries	147	3.46	1.002	-1.585	0.114
	215	3.63	1.024		
Apps	147	3.62	0.989	-0.206	0.837
	215	3.64	1.062		
File management systems	147	3.89	0.861	-1.133	0.258
	215	4.00	0.922		
Search engines	147	4.29	0.829	-1.205	0.229
	215	4.40	0.836		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Non-science majors: *n* = 147; Science majors: *n* = 215.

Differences between High GPA and Low GPA

To examine the relationship between participants' GPA and their preferences for technology that enhances interactions with other learners, with the instructor, with course content, and with course technology in online courses, participants were divided into two groups by GPA: high GPA and low GPA. The high GPA group included participants who reported a GPA from 3.0 to 4.0. The low GPA group included participants who reported a GPA at or below 2.9.

An independent-samples t-test was conducted to compare high GPA and low GPA participants' preferences for technology to enhance learner-to-learner interaction, as shown in Table 54. There was no significant difference between high GPA and low GPA students' preferences for email, audio/phone call, social media, instant messaging, blogging, and collaborative documents to enhance learner-to-learner interaction. These results suggest that GPA may not be a factor that influences participants' preferences for technology that can enhance learner-to-learner interaction.

Table 54
Differences between High and Low GPA Participants' Preferences for Technologies to Enhance Learner-to-Learner Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Email	249	3.19	1.123	0.887	0.376
	113	3.08	1.127		
Audio/phone call	249	2.99	0.986	1.195	0.233
	113	2.85	1.096		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. High GPA: $n = 249$; Low GPA: $n = 113$.

Table 54 Continued

Technology	*n*	*Mean*	*SD*	*t*	*p*
Social Media	249	3.49	1.055	-0.148	0.882
	113	3.50	1.196		
Instant messaging	249	3.84	1.022	0.448	0.655
	113	3.79	1.250		
Blogging	249	2.59	0.967	1.092	0.275
	113	2.48	0.877		
Collaborative documents	249	4.08	0.998	1.236	0.217
	113	3.94	1.136		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. High GPA: $n = 249$; Low GPA: $n = 113$.

An independent-samples t-test was conducted to compare participants' preferences for technology that can enhance learner-to-instructor interaction between high GPA and low GPA, as shown in Table 55. There was no significant difference between high GPA and low GPA students' preferences for lecture, video, email, voice-over PowerPoint, online editing and feedback, audio/phone calls, and evaluation to enhance learner-to-instructor interaction. These results suggest that GPA may not be a factor that influences participants' preferences for technology to enhance learner-to-instructor interaction.

Table 55
Differences between High and Low GPA Participants' Preferences for Technologies to Enhance Learner-to-Instructor Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Lecture	249	4.33	0.785	1.601	0.110
	113	4.18	0.947		
Video	249	3.51	1.000	-0.262	0.794
	113	3.54	1.009		
Email	249	3.98	0.823	1.585	0.114
	113	3.82	1.037		
Voice over PowerPoint	249	3.22	1.120	-0.141	0.888
	113	3.24	1.152		
Online editing and feedback	249	3.69	0.973	-0.447	0.655
	113	3.74	0.924		
Audio/phone call	249	2.91	0.967	-0.409	0.683
	113	2.96	0.910		
Evaluation	249	3.69	0.918	0.752	0.453
	113	3.61	0.986		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. High GPA: $n = 249$; Low GPA: $n = 113$.

An independent-samples t-test was conducted to compare high GPA and low GPA participants' preferences for technology that enhances learner-to-course content interaction, as shown in Table 56. There was no significant difference between high GPA and low GPA students' preferences for using text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercise, podcasting, and collaborative documents to enhance learner-to-course content interaction. These results suggest that GPA may not be an influencing factor on participants' preferences for technology to enhance learner-to-course content interaction.

Table 56
Differences between High and Low GPA Participants' Preferences for Technologies to Enhance Learner-to-Course Content Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Text / Textbooks	249	3.60	1.035	-0.480	0.632
	113	3.65	1.042		
Support materials	249	3.93	0.868	-0.371	0.711
	113	3.96	0.896		
Case studies	249	3.83	0.906	1.557	0.120
	113	3.66	0.969		
PowerPoint	249	4.18	0.794	0.565	0.572
	113	4.12	0.888		
Interactive video	249	3.80	0.946	-0.865	0.388
	113	3.89	1.003		
Online practice exercises	249	4.09	0.825	-0.904	0.367
	113	4.18	0.826		
Podcasting	249	3.01	0.967	-0.324	0.746
	113	3.04	1.021		
Collaborative documents	249	3.93	0.907	0.956	0.340
	113	3.83	0.953		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. High GPA: $n = 249$; Low GPA: $n = 113$.

An independent-samples t-test was conducted to compare high GPA and low GPA participants' preferences for technology that enhances learner-to-course technology interaction, as shown in Table 57. There was no significant difference between high GPA and low GPA students' preferences for using online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, apps, file management systems, and search engines to enhance learner-to-course technology interaction. These results suggest that GPA may not be an influencing factor on participants' preferences toward technology to enhance learner-to-course technology interaction.

Table 57
Differences between High and Low GPA Participants' Preferences for Technologies to Enhance Learner-to-Course Technology Interaction as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

Technology	*n*	*Mean*	*SD*	*t*	*p*
Online tutorials	249	3.71	0.936	-1.369	0.172
	113	3.86	0.981		
Getting help online	249	3.58	0.973	0.677	0.499
	113	3.50	1.103		
Online instructions for downloading	249	3.39	0.935	0.123	0.902
plugins	113	3.37	1.112		
Electronic libraries	249	3.55	0.987	-0.105	0.916
	113	3.57	1.085		
Apps	249	3.63	1.013	-0.167	0.868
	113	3.65	1.077		
File management systems	249	3.96	0.888	0.127	0.899
	113	3.95	0.924		
Search engines	249	4.34	0.828	-0.507	0.612
	113	4.39	0.850		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. High GPA: $n = 249$; Low GPA: $n = 113$.

Findings Related to Objective Nine

The ninth objective was to examine the relationship between students' selected personal characteristics and students' satisfaction, perceived quality, and perception of learning increase when interactions are provided during an online learning experience.

Differences between Genders

To examine the relationship between participants' gender and their attitudes toward satisfaction, perceived quality, and perception of learning increase when four

kinds of interactions are provided in an online learning experience, participants were divided into two groups by gender: male and female.

An independent-samples t-test between males and females was conducted to compare participants' satisfaction with and perceived quality of online learning experiences and the increase in learning when interactions are provided in online courses, as shown in Table 58. There was a significant difference between male participants (M = 2.00, SD = 0.001) and female participants (M = 1.96, SD = 0.20); t (360) = 2.161, p = 0.03, regarding satisfaction when learner-to-instructor interaction was provided. These results suggest that males have greater agreement than females that the satisfaction of a learning experience increased when learner-to-instructor interaction was provided in an online course.

Table 58

Differences between Genders in Agreement toward the Satisfaction, Quality, and Increased Learning of the Online Learning Experiences when Four Types of Interactions were Provided as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

	n	*Mean*	*SD*	*t*	*p*
Satisfaction					
Opportunities for interaction with	105	1.83	0.379	-0.185	0.853
other learners provided	257	1.84	0.370		
Opportunities for interaction with	105	2.00	0.000	2.161	0.031*
the instructor provided	257	1.96	0.203		
Opportunities for interaction with	105	1.98	0.137	0.025	0.980
the course content provided	257	1.98	0.138		
Opportunities for interaction with	105	1.78	0.416	0.604	0.546
the course technology provided	257	1.75	0.433		
Quality					
Opportunities for interaction with	105	1.84	0.370	0.214	0.831
other learners provided	257	1.83	0.377		
Opportunities for interaction with	105	2.00	0.000	1.439	0.151
the instructor provided	257	1.98	0.138		
Opportunities for interaction with	105	1.97	0.167	-0.289	0.773
the course content provided	257	1.98	0.151		
Opportunities for interaction with	105	1.78	0.416	0.057	0.955
the course technology provided	257	1.78	0.416		
Learning					
Opportunities for interaction with	105	1.87	0.342	0.717	0.474
other learners provided	257	1.84	0.370		
Opportunities for interaction with	105	1.99	0.098	0.446	0.656
the instructor provided	257	1.98	0.124		
Opportunities for interaction with	105	1.98	0.137	0.252	0.801
the course content provided	257	1.98	0.151		
Opportunities for interaction with	105	1.80	0.402	0.215	0.830
the course technology provided	257	1.79	0.408		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Male: *n* = 105; Female: *n* = 257.

Differences between Upper and Lower Classifications

To examine the relationship between participants' classification and their attitudes toward satisfaction, quality, and learning increase when four kinds of interactions are provided in an online learning experience, participants were divided into two groups by classification: upper classification and lower classification. The upper classification included participants who were juniors or seniors. The lower classification included participants who were freshman or sophomores.

An independent-samples t-test was conducted to compare upper classification with lower classification participants' satisfaction, perception of quality, and perception of learning increase during an online learning experience when learner-to-learner interactions were provided, as shown in Table 59. There was a significant difference between upper classification students (M = 1.98, SD = 0.13) and lower classification students (M = 1.94, SD = 0.23); t (360) = 2.12, p = 0.04, regarding satisfaction when learner-to-instructor interactions were provided. There was also a significant difference between upper classification students (M = 1.99, SD = 0.09) and lower classification students (M = 1.94, SD = 0.23); t (360) = 2.83, p = 0.01, regarding perception of quality when learner-to-course content interaction was provided.

These results suggest that upper classification students have more agreement than lower classification students regarding the satisfaction of a learning experience when learner-to-instructor interaction was provided, and regarding the quality of a learning experience when learner-to-course content interaction was provided in the online course.

Table 59

Differences between Upper Classification and Lower Classification Participants in Agreement toward the Satisfaction, Quality, and Learning Increases of the Online Learning Experiences when Four Types of Interactions were Provided as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

	n	*Mean*	*SD*	*t*	*p*
Satisfaction					
Opportunities for interaction with other learners provided	239	1.85	0.354	1.377	0.170
	123	1.80	0.404		
Opportunities for interaction with the instructor provided	239	1.98	0.129	2.116	0.035*
	123	1.94	0.233		
Opportunities for interaction with the course content provided	239	1.98	0.129	0.500	0.618
	123	1.98	0.155		
Opportunities for interaction with the course technology provided	239	1.75	0.432	-0.404	0.686
	123	1.77	0.421		
Quality					
Opportunities for interaction with other learners provided	239	1.85	0.362	0.969	0.333
	123	1.80	0.398		
Opportunities for interaction with the instructor provided	239	1.98	0.129	-0.663	0.508
	123	1.99	0.090		
Opportunities for interaction with the course content provided	239	1.99	0.091	2.833	0.005*
	123	1.94	0.233		
Opportunities for interaction with the course technology provided	239	1.78	0.416	-0.049	0.961
	123	1.78	0.416		
Learning					
Opportunities for interaction with other learners provided	239	1.85	0.358	0.298	0.766
	123	1.84	0.371		
Opportunities for interaction with the instructor provided	239	1.98	0.129	-0.663	0.508
	123	1.99	0.090		
Opportunities for interaction with the course content provided	239	1.98	0.129	0.966	0.335
	123	1.97	0.178		
Opportunities for interaction with the course technology provided	239	1.79	0.411	-0.405	0.686
	123	1.80	0.398		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Upper classification: $n = 239$; Lower classification: $n = 123$.

Differences between Non-science and Science Majors

To examine the relationship between participants' majors and their attitudes toward satisfaction, quality, and learning increase when four kinds of interactions are provided in an online learning experience, participants were divided into two groups by majors: non-science majors and science majors. The non-science majors group included participants whose majors were in the following departments: Agricultural Economics; Agricultural Leadership, Education, and Communications; and Recreation, Park and Tourism Science. The science majors group included participants whose majors were in the following departments: Animal Science, Biochemistry and Biophysics, Biological and Agricultural Engineering, Ecosystem Science and Management, Entomology, Horticultural sciences, Nutrition and Food Science, Plant Pathology and Microbiology, Poultry Science, Soil and Crop Sciences, and Wildlife and Fisheries Sciences.

An independent-samples t-test was conducted to compare participants' attitudes toward satisfaction with and quality of the online learning experiences, and the increase in learning when learner-to-learner interactions were provided in online courses between non-science and science majors, as shown in Table 60. There was no significant difference between non-science major students and science major students in their attitudes toward satisfaction with and quality of online learning experiences, and the increase in learning when four types of interactions were provided in online courses.

Table 60

Differences between Non-Science and Science Majors Participants in Agreement toward the Satisfaction, Quality, and Increase in Learning of the Online Learning Experiences when Four Types of Interactions were Provided as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

	n	*Mean*	*SD*	*t*	*p*
Satisfaction					
Opportunities for interaction with	147	1.86	0.344	1.255	0.210
other learners provided	215	1.81	0.390		
Opportunities for interaction with	147	1.97	0.163	0.290	0.772
the instructor provided	215	1.97	0.178		
Opportunities for interaction with	147	1.97	0.163	-0.898	0.370
the course content provided	215	1.99	0.118		
Opportunities for interaction with	147	1.76	0.427	0.082	0.935
the course technology provided	215	1.76	0.429		
Quality					
Opportunities for interaction with	147	1.85	0.358	0.791	0.430
other learners provided	215	1.82	0.386		
Opportunities for interaction with	147	1.98	0.142	0.888	0.375
the instructor provided	215	1.99	0.096		
Opportunities for interaction with	147	1.98	0.142	0.449	0.654
the course content provided	215	1.97	0.165		
Opportunities for interaction with	147	1.79	0.409	0.382	0.702
the course technology provided	215	1.77	0.420		
Learning					
Opportunities for interaction with	147	1.87	0.337	1.106	0.270
other learners provided	215	1.83	0.378		
Opportunities for interaction with	147	1.98	0.142	-0.888	0.375
the instructor provided	215	1.99	0.096		
Opportunities for interaction with	147	1.98	0.142	0.181	0.857
the course content provided	215	1.98	0.151		
Opportunities for interaction with	147	1.80	0.399	0.383	0.702
the course technology provided	215	1.79	0.411		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. Non-science majors: *n* = 147; Science majors: *n* = 215.

Differences between High GPA and Low GPA

To examine the relationship between participants' GPA and their attitudes toward satisfaction, quality, and learning increase when four kinds of interactions are provided in an online learning experience, participants were divided into two groups by GPA: high GPA and low GPA. The high GPA group included participants who reported a GPA from 3.0 to 4.0. The low GPA group included participants who reported a GPA at or below 2.9.

An independent-samples t-test was conducted to compare participants based on high and low GPA regarding satisfaction, perception of quality, and learning increase when interactions were provided in an online course, as shown in Table 61. There was a significant difference between high GPA students (M = 2.00, SD = 0.06) and low GPA students (M = 1.96, SD = 0.19); t (360) = 2.38, p = 0.02, regarding the perception of quality of a learning experience when learner-to-instructor interaction was provided. These results suggest that high GPA students have greater agreement than low GPA students that the quality of a learning experience increased when learner-to-instructor interaction was provided in the online course.

Table 61

Differences between High and Low GPA Participants in Agreement with the Satisfaction, Quality, and Increased Learning of the Online Learning Experiences when Four Types of Interactions were Provided as Reported by Participants in the College of Agriculture and Life Sciences, Texas A&M University, Spring 2017

	n	*Mean*	*SD*	*t*	*p*
Satisfaction					
Opportunities for interaction with	249	1.84	0.368	0.387	0.699
other learners provided	113	1.82	0.383		
Opportunities for interaction with	249	1.97	0.166	0.373	0.709
the instructor provided	113	1.96	0.186		
Opportunities for interaction with	249	1.98	0.154	-0.975	0.330
the course content provided	113	1.99	0.094		
Opportunities for interaction with	249	1.76	0.431	-0.306	0.759
the course technology provided	113	1.77	0.423		
Quality					
Opportunities for interaction with	249	1.84	0.372	0.290	0.772
other learners provided	113	1.82	0.383		
Opportunities for interaction with	249	2.00	0.063	2.383	0.018*
the instructor provided	113	1.96	0.186		
Opportunities for interaction with	249	1.97	0.166	-0.588	0.557
the course content provided	113	1.98	0.132		
Opportunities for interaction with	249	1.78	0.416	0.008	0.994
the course technology provided	113	1.78	0.417		
Learning					
Opportunities for interaction with	249	1.85	0.360	0.162	0.871
other learners provided	113	1.84	0.368		
Opportunities for interaction with	249	1.99	0.089	1.399	0.163
the instructor provided	113	1.97	0.161		
Opportunities for interaction with	249	1.98	0.141	0.387	0.699
the course content provided	113	1.97	0.161		
Opportunities for interaction with	249	1.79	0.407	-0.115	0.909
the course technology provided	113	1.80	0.404		

Note. * $p < 0.05$. The scale for answers was: Strongly Disagree = 1; Disagree = 2; Neither Agree nor Disagree = 3; Agree = 4; Strongly Agree = 5. High GPA: $n = 249$; Low GPA: $n = 113$.

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

This chapter presents a summary of the study including the purpose, objectives, methodology, and findings. Then, conclusions, implications, and recommendations are presented by objective based on findings. Finally, implications and recommendations for practice, recommendations for research, and theoretical contributions are offered.

Summary

The purpose of this quantitative study was to examine and identify undergraduate students' perceptions regarding technology use for enhancing interactions in online learning environments. Undergraduate students who were majoring in the College of Agriculture and Life Sciences at Texas A&M University were the target population for this study.

Moore's (1989) transactional distance theory was used as the theoretical framework for the study. The nine specific objectives identified for this purpose were:

1. Identify and describe student perceptions of specific technology use to enhance learner-to-learner interaction for online learning.
2. Identify and describe student perceptions of specific technology use to enhance learner-to-instructor interactions for online learning.
3. Identify and describe student perceptions of specific technology use to enhance learner-to-course content interactions for online learning.

4. Identify and describe student perceptions of specific technology use to enhance learner-to-course technology interactions for online learning.
5. Identify and describe students' satisfaction, perception of quality, and perception of learning increase when interactions are provided during an online learning experience.
6. Explore and describe which technologies in an online learning environment can be a significant predictor of students' satisfaction, perceived quality, and perception of learning increase when interactions are provided during an online learning experience.
7. Determine and describe students' preferences for technologies used to enhance interactions for online learning.
8. Examine the relationship between students' selected personal characteristics and preference for technologies to enhance interactions in online learning.
9. Examine the relationship between students' selected personal characteristics and students' satisfaction, perceived quality, and perception of learning increase when interactions are provided during an online learning experience.

The study instrument was based on the four types of interactions of Moore's (1989) transactional distance theory, contained six main sections, and used a five-point Likert-type scale to measure participants' attitudes about technology use and interactions. The instrument also collected respondents' preference of learning delivery format and basic demographic data (i.e., gender, classification, major, and GPA score).

The instrument was reviewed for reliability and validity prior to implementation. The reliability review for each area of the survey revealed the following scores: total interactions ($\alpha = 0.89$); learner-to-course technology subscale ($\alpha = 0.83$); learner-to-learner interaction subscale ($\alpha = 0.74$); learner-to-course content interaction subscale ($\alpha = 0.78$); learner-to-instructor interaction subscale ($\alpha = 0.68$); and the satisfaction, quality, and learning subscale ($\alpha = 0.67$).

An online questionnaire was used for data collection. Target respondents received an invitation to participate by email or via intercept data collection method. Data collection was completed in early March 2017. SPSS 23.0 was used to analyze data. Descriptive analyses were conducted to present the mean, standard deviation, frequencies, and percentages of specific technologies used to enhance four types of interactions and learners' attitudes toward satisfaction with online learning experiences, quality of online learning experiences, and increase in learning when four types of interactions were provided in online courses. Exploratory factor analysis was used to explore which specific technologies were highly correlated with enhancement of the four types of interactions by using principal component analysis with varimax rotation. Logistical regression analyses were used to explore and describe which types of technology used in online courses can be a significant predictor of learners' satisfaction with online learning experiences, quality of online learning experiences, and increased learning in online courses when four types of interactions were provided in online courses. Independent-samples t-test analyses were used to examine the relationship between students' selected personal characteristics (i.e., gender, classification, major,

and GPA score) and preferences for technology to enhance the four types of interactions in online courses and their attitudes toward satisfaction with the online learning experiences, quality of the online learning experiences, and increases in learning when four types of interactions were provided in online courses.

A total of 362 College of Agriculture and Life Sciences undergraduate students participated in the study. The majority of respondents were female students (71%). As for the respondents' classification, most students were class of seniors (28.2%) and juniors (34%). The majority of respondents were majoring in the Department of Agricultural Leadership, Education, and Communications (23.5%) and in the Department of Animal Science (19.6%). The largest number of respondents (33.7%) reported GPA scores that ranged from 3.0 - 3.4. Finally, the majority of participants (71.5%) reported that they preferred face-to-face as a course delivery format rather than an online course or blended method course.

Table 62 shows the summary of significant findings across objectives. This study focused on two main areas including four types of interactions and learners' perceptions of satisfaction, quality, and learning of online learning experiences. According to Table 62, we found that there were significant differences among participants' characteristics such as gender, classification, major, and total GPA score. There were also significant differences regarding learners' perceptions of technology to enhance interactions in online courses between participants' gender and major. These results indicate that gender and major can influence which technologies may effectively enhance interactions in an online course. Regarding participants' perceptions of satisfaction, quality, and

learning in online courses, there were significant differences among learners of differing genders, classifications, and GPAs when the four types of interactions are provided. Instructors should consider learners' characteristics, including gender, classification, and GPA, to provide appropriate interaction in their online course and effectively improve the learners' perceptions of satisfaction, quality, and learning in regard to their online learning experience.

Table 62
Summary of Significant Findings across Objectives

	Male	Female	Upper Classification	Lower Classification	Science Major	Non-Science Major	High GPA	Low GPA
Interactions								
Learner	No	No	No	No	Yes	No	No	No
Instructor	Yes	Yes	No	No	Yes	Yes	No	No
Course Content	No	Yes	No	No	Yes	No	No	No
Course Technology	No	Yes	No	No	No	No	No	No
Satisfaction, Quality, and Learning								
Satisfaction	Yes	No	Yes	No	No	No	No	No
Quality	No	No	Yes	No	No	No	Yes	No
Learning	No	No	No	No	No	No	No	No

Note: Yes = Significant difference toward technology use; No = No significant difference toward technology use.

Conclusions, Implications, and Recommendations

Each of the nine objectives is addressed individually with key findings followed by conclusions, implications and recommendations relevant to that objective.

Objective One: Key Findings

The first objective was to identify and describe student perceptions of using specific technologies to enhance learner-to-learner interaction for online learning. The specific technologies identified that can enhance interaction with other learners were email, audio/phone calls, social media, instant messaging, blogging, and collaborative documents.

Overall, the mean and standard deviation for participants' attitudes toward the use of specific technologies to enhance learner-to-learner interaction were $M = 3.34$ and $SD = 0.56$. Percentages of participants who either agreed or strongly agreed that these technologies enhanced learner-to-learner interactions were as follows: collaborative documents, 80.4%; instant messaging, 74.8%; social media, 61.9%; e-mail, 47%; audio/phone call, 33.4%; and blogging, 16%.

To generate the factor structure of technologies to enhance learner-to-learner interaction, a principal component analysis with varimax rotation was conducted for the six items ($n = 362$). This analysis resulted in a one-factor solution that explained 43.86% of the total variance. The factor was labeled "learner-to-learner interaction tool" and included 6 items (i.e., email, audio/phone calls, social media, instant messaging, blogging, and collaborative documents). The reliability for this factor ($\alpha = 0.74$) was acceptable.

Objective One: Conclusions

From the descriptive results, respondents tended to neither agree nor disagree that using technologies such as email, audio/phone calls, social media, instant messaging, blogging, and collaborative documents in online courses could increase learner-to-learner interaction. The usage of collaborative, instant messaging, and social media may enhance learner-to-learner interaction in the online course, but blogging may not be a preferred technology for students to enhance learner-to-learner interactions in the online course. The exploratory factor analysis did not reveal groupings among the technologies (6 items).

Objective One: Implications

The results suggested that the use of email, audio/phone calls, social media, instant messaging, blogging, and collaborative documents may enhance learner-to-learner interaction in the online course. Specifically, the use of collaborative documents, instant messaging, and social media may have greater positive effects on students in online learning. The results also revealed that instructors should evaluate the use of blogging in course design because this technology may not be a preferred tool to enhance interaction. Instructors must consider the use of email, audio/phone calls, social media, instant messaging, blogging, and collaborative documents in the online course to create a helpful and appropriate teaching setting. Some of these results agree well with previous findings that online and instant chat tools were effective technologies, and blogging was a less effective technology to enhance learner-to-learner interactions

(Chang, 2013; Seidel, 2012). These results are also consistent with earlier findings showing that American students enjoy using technology for online communications (Liu et al., 2010; Wang, 2007).

Objective One: Recommendations

Further research is needed to understand why learners disagree with the usage of blogging to enhance the learner-to-learner interaction and why the exploratory factor analysis for the learner-to-learner interaction scale only identified one factor as significant with moderate reliability. Six items may not be sufficient for exploratory factor analysis for the learner-to-learner interaction scale. For example, researchers could list all types of popular social media such Facebook, Instagram, or Twitter as items in the learner-to-learner interaction scale instead of just using the term "social media" to represent all types of technology. Adding items to the scale could provide more accurate results to classify factors of technology.

Objective Two: Key Findings

The second objective was to identify and describe student perceptions of specific technology use to enhance learner-to-instructor interactions for online learning. The specific technologies identified to enhance interaction with the instructor were lecture, video, email, voice-over PowerPoint, online editing and feedback, audio/phone calls, and evaluation.

Overall, the mean and standard deviation for participants' attitudes toward use of these specific technologies to enhance learner-to-instructor interaction were $M = 3.61$ and $SD = 0.45$. Percentages of participants who either agreed or strongly agreed that these technologies enhanced learner-to-instructor interactions were as follows: lecture, 92%; email, 80.2%; online editing and feedback, 65.5%; evaluation, 62.7%; video, 57.7%; voice-over PowerPoint, 46.1%; and audio/phone calls, 26.5%.

To generate the factor structure of technologies that enhance learner-to-instructor interaction, a principal component analysis with varimax rotation was conducted for the seven items ($n = 362$). This analysis resulted in three factor solutions that explained 66.75% of the total variance and 35.21% of the variance for Factor 1, 17.2% of the variance for Factor 2, and 14.34% of the variance for Factor 3. Factor 1 was labeled "feedback tool" and included 2 items: evaluation and online editing and feedback. Factor 2 was labeled "sonic interaction tool" and included 3 items: voice-over PowerPoint, video, and audio/phone calls. Factor 3 was labeled "learner-to-instructor interaction tool" and included 2 items that are regarded as more traditional methods to interact with the instructor: lecture and e-mail. The reliability was questionable for Factor 1 ($\alpha = 0.63$) and was poor for Factor 2 ($\alpha = 0.56$) and Factor 3 ($\alpha = 0.58$).

Objective Two: Conclusions

From the descriptive results, respondents tended to agree that using technologies such as lecture, video, email, voice-over PowerPoint, online editing and feedback, audio/phone calls, and evaluation in online courses could increase learner-to-instructor

interaction. While three of these (i.e., lecture, email, and online editing and feedback) may enhance learner-to-instructor interaction in the online course, two of them (i.e., voice-over PowerPoint and audio/phone calls) may not be preferred technologies to enhance learner-to-instructor interactions.

From the results of exploratory factor analysis, three distinct factors were found to be underlying responses to the specific technologies to enhance learner-to-instructor interaction. Based on a principal component analysis with varimax rotation, the three-factor structure included the feedback tool factor (two items: evaluation and online editing and feedback), sonic interaction tool factor (three items: voice over PowerPoint, video, and audio/phone call), and learner-to-instructor interaction tool factor (two items: lecture and email) was evident.

Objective Two: Implications

These results suggested that the use of lecture, video, email, voice-over PowerPoint, online editing and feedback, audio/phone calls, and evaluation may enhance learner-to-instructor interaction in the online course. Specifically, the use of lecture, email, and online editing and feedback may have more positive effects on students in online learning. Instructors should consider the use of lecture, video, email, voice-over PowerPoint, online editing and feedback, audio/phone call, and evaluation in the online course to create a helpful and appropriate teaching setting. These findings support Seidel's (2012) conclusion that lecture, e-mail, and online editing and feedback were effective technologies to enhance learner-to-instructor interaction in an online course.

The results also revealed that instructors should evaluate the usage of voice-over PowerPoint and audio/phone calls in course design as those technologies may not be an effective tool to enhance interaction in an online course. The tendency of students to disagree with using voice over PowerPoint to enhance learner-to-instructor interaction may be explained as follows. First, some videos of voice over PowerPoint are too long. Students can be easily distracted and may find it difficult to focus on the content. Videos around three to five minutes in length are more effective for student learning. Second, voice-over PowerPoint provides only one-way interaction between the instructor and students. Students simply listen to the presentation of the PowerPoint from the instructor but cannot ask questions or share additional examples during online lecture. Hence, this technology lacks the corresponding interaction between students and the instructor. Therefore, the results show that instructors should be cautious with the use of voice-over PowerPoint in their online course design.

Students tended to disagree that using audio/phone calls could enhance learner-to-instructor interaction in the online course because audio/phone calls may not be an effective tool to communicate with the instructor. In a comparison with email and audio/phone calls, students tended to use email to contact instructors because it allowed students additional time to think and organize their questions and sentences before presenting their question to the instructor (McIsaac et al., 1999). Also, students can communicate at any time needed via email. However, communicating with the instructor with audio/phone calls limits the time available for discussion, may prevent students from expressing ideas clearly, and does not provide a written record of points discussed

like email. These concerns may explain why audio/phone calls were the least effective technologies to enhance learner-to-instructor interaction.

From the results of the exploratory factor analysis, there were three significant factors for types of technology that enhance learner-to-instructor interaction in an online course, including factors of feedback tools, sonic interaction tools, and learner-to-instructor interaction tools. Instructors should consider using technologies that have features of all three factors to help learners by enhancing learner-to-instructor interaction in online learning environments.

Objective Two: Recommendations

Further research is needed to understand why learners neither agree nor disagree with the use of voice-over PowerPoint and audio/phone calls to enhance learner-to-instructor interaction. Also, further research is needed to improve the reliability of factors of feedback tools, sonic interaction tools, and learner-to-instructor interaction tools, and the reliability of the learner-to-instructor interaction scale. Seven items for the learner-to-instructor interaction scale may not be sufficient for exploratory factor analysis, but adding items to the learner-to-instructor interaction scale could improve future studies. For example, researchers could list all types of popular audio/phone call technology, such Skype or Facetime, as items in the learner-to-instructor interaction scale instead of simply using the term “audio/phone call” to represent all types of technology.

Objective Three: Key Findings

The third objective of this study was to identify and describe student perceptions of specific technology use to enhance learner-to-course content interactions for online learning. Specific technologies that can enhance interaction with the course content were text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercises, podcasting, and collaborative documents.

Overall, the mean and standard deviation for participants' attitudes toward specific technologies use for enhancing learner-to-course content interaction were M = 3.8 and SD = 0.36. Percentages of participants who either agreed or strongly agreed that the following technologies enhanced learner-to-course content interactions were as follows: PowerPoint, 88.4 %; online practice, 85.9%; support materials, 79.5%; collaborative documents, 74.1%; interactive video, 71.5%; case studies, 68.8%; text/textbooks, 66.8%; and podcasting, 30.4%.

To generate the factor structure of technologies to enhance learner-to-course content interaction, a principal component analysis with varimax rotation was conducted for the eight items (n = 362). This analysis resulted in two factor solutions that explained 54.10% of the total variance, 39.59% of the variance for Factor 1, and 14.50% of the variance for Factor 2. Factor 1 was labeled "active learning tool" and included 6 technologies: case studies, PowerPoint, interactive video, online practice exercises, podcasting, and collaborative documents. Factor 2 was labeled "reading" and included 2 technologies: text/textbooks and support materials. The reliability was acceptable for Factor 1 ($\alpha = 0.76$) and poor for Factor 2 ($\alpha = 0.67$).

Objective Three: Conclusions

From the descriptive results, respondents tended to agree that technologies such as text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercises, podcasting, and collaborative documents could be used to increase learner-to-course content interaction in online courses. The use of PowerPoint, online practice, support material, and collaborative documents may enhance learner-to-course content interaction in the online course, but podcasting may not be a preferred technology to enhance learner-to-course content interactions for students in the online course.

From the results of the exploratory factor analysis, two distinct factors were underlying responses to the specific technologies that could enhance learner-to-course content interaction. Based on a principal component analysis with varimax rotation, the two-factor structure, including the active learning tool factor (six items: collaborative documents, interactive video, online practice exercises, PowerPoint, case studies, and podcasting) and reading factor (two items: text/textbook and support materials), was evident.

Objective Three: Implications

The results suggest that the usage of text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercises, podcasting, and collaborative documents may enhance learner-to-course content interaction in an online course. Specifically, the use of PowerPoint, online practice, support material, and

collaborative documents may have more positive effects on students in online learning. The results also revealed that instructors should evaluate the use of podcasting in course design because this technology may not be an effective tool for students to enhance interaction in the online course. Instructors should consider using text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercises, podcasting, and collaborative documents in the online course to create a helpful and appropriate teaching setting. These results were consistent with earlier findings showing that support materials and online exercises were effective technologies to enhance learner-to-course content interaction in the online course (Chang, 2013; Seidel, 2012).

Exploratory factor analysis revealed two significant factors for technologies to enhance learner-to-course content interaction: active learning tools and reading tools. Instructors should focus on using technologies that have features of both factors to support learners by enhancing learner-to-course content interaction in online learning environments.

Objective Three: Recommendations

Further research is needed to understand why learners disagree with the usage of podcasting to enhance learner-to-course content interaction. Also, further research is needed to improve the reliability of the interaction scale for active learning tools, reading tools, and the learner-to-course content. Eight items for the learner-to-course content interaction scale may not be sufficient for the exploratory factor analysis. For example, researchers could list all types of popular collaborative documents technology such

Google Docs or Quip as items in the learner-to-course content interaction scale instead of using the term “collaborative documents” to represent all types of technologies.

Objective Four: Key Findings

The fourth objective was to identify and describe student perceptions of specific technology use to enhance learner-to-course technology interactions for online learning. Specific technologies identified that enhance interaction with course technology were online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, apps, file management systems, and search engines.

Overall, the mean and standard deviation for participants’ attitudes toward using specific technologies to enhance learner-to-course technology interaction were $M = 3.74$ and $SD = 0.33$. Percentages of participants who either agreed or strongly agreed that the following technologies enhanced learner-to-course technology interactions were: search engines, 89.5%; file management systems, 77%; online tutorials, 72.7%; apps, 63.6%; getting help online, 62.2%; electronic libraries, 57.5%; and online instructions for downloading plugins, 49.8%.

To generate the factor structure of technologies to enhance learner-to-course technology interaction, a principal component analysis with varimax rotation was conducted for the 7 items ($n = 362$). This analysis resulted in a one-factor solution that explained 50.08% of the total variance. Factor 1 was labeled “learner-to-course technology interaction tool” and included seven technologies (i.e., online tutorials, getting help online, online instructions for downloading plugins, electronic libraries,

apps, file management systems, and search engines). The reliability for this factor (α = 0.83) was acceptable.

Objective Four: Conclusions

From the descriptive results, respondents tended to agree that technologies such as online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, apps, file management systems, and search engines could be used in online courses to increase learner-to-course technology interaction. The use of search engines, file management systems, and online tutorials may enhance learner-to-course technology interaction in the online course, but online instructions for downloading plugins may not be an effective technology to enhance learner-to-course technology interactions for students in the online course. From the results of the exploratory factor analysis, only one distinct factor, labeled learner-to-course technology interaction tool (seven items), was underlying responses to the specific technologies that enhance learner-to-course technology interaction. These technologies did not separate into factors.

Objective Four: Implications

The results suggested that the use of online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, apps, file management systems, and search engines may enhance learner-to-course technology interaction in the online course. Specifically, the use of search engines, file management systems, and

online tutorials may have a more positive impact on students in online learning. The results also revealed that instructors should evaluate the use of online instructions for downloading plugins in course design. Instructors must consider using online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, apps, file management systems, and search engines in the online course to create a helpful and appropriate teaching setting. These results agree with the identification of online tutorials as effective technology and online instruction for downloading plugins as a less effective technology to enhance learner-to-course technology interaction in the online course (Seidel, 2012).

Objective Four: Recommendations

Further research is needed to understand why learners disagree with the usage of online instructions for downloading plugins to enhance learner-to-course technology interaction and why the exploratory factor analysis for the learner-to-course technology interaction scale identified only one factor as significant with moderate reliability. Seven items for the learner-to-course interaction scale may not be adequate for exploratory factor analysis. Adding items to the learner-to-course technology interaction scale may be necessary for future studies. For example, researchers could list all types of popular search engine technology such Google, Bing, or Yahoo search as items in the learner-to-course interaction scale instead of only using the term “search engines” to represent all examples of this technology type.

Objective Five: Key Findings

The fifth objective of this study was to identify and describe students' satisfaction, perception of quality, and perception of learning increase when interactions are provided during an online learning experience.

Satisfaction. Percentages of respondents who agreed that they perceived high satisfaction with the online learning experience when opportunities for multiple types of interaction were provided in the online course were as follows: learner-to-course content interaction, 98.1%; learner-to-instructor interaction, 97.0%; learner-to-learner interaction, 83.4%; and learner-to-course technology, 76.0%.

Quality. Percentages of respondents who agreed that they perceived higher quality of the online learning experience when opportunities for different types of interactions were provided in the online course were as follows: learner-to-instructor interaction, 98.6%; learner-to-course content interaction, 97.5%; learner-to-learner interaction, 83.1%; and learner-to-course technology, 77.9%.

Learning. Percentages of respondents who agreed that they perceived increased learning when opportunities for different types of interactions were provided in the online course were as follows: learner-to-instructor interaction, 98.6%; learner-to-course content interaction, 97.8%; learner-to-learner interaction, 84.5%; and learner-to-course technology, 79.3%.

Objective Five: Conclusions

From the descriptive results, respondents tended to agree that they perceived higher satisfaction with the online learning experience when opportunities for interaction with the course content, with the instructor, with other learners, and with the course technology were provided. Respondents also tended to agree that they perceived higher quality of the online learning experience when opportunities for interaction with the instructor, with the course content, with other learners, and with the course technology were provided. Additionally, respondents tended to agree that they perceived increased learning when opportunities for interaction with the instructor, with the course content, with other learners, and with the course technology were provided.

Objective Five: Implications

The results suggest that learner-to-learner interaction, learner-to-instructor interaction, learner-to-course content interaction, and learner-to-course technology interaction may enhance learners' satisfaction with the online learning experience, the quality of the online learning experience, and increase in learning in the online course. Students agree more with the statements that they perceived higher satisfaction with and quality of online learning experiences and that learning increased when learner-to-instructor interaction and learner-to-course content interaction were provided in an online course. These results agree with earlier findings that learner-to-course content interaction and leaner-to-instructor interaction were significant influencers of learners' attitudes toward the satisfaction with online learning experiences (Chang, 2013; Jung et

al., 2002; Seidel, 2002; Strachota, 2003), the quality of online learning experiences (Chang, 2013; Su et al., 2005), and increases in learning (Chang, 2013; Jung et al., 2002; Seidel, 2002) in online learning environments.

Learner-to-learner and learner-to-course technology interactions have less influence on students' attitudes toward satisfaction with and quality of online learning experiences and increased learning in an online course. To enhance learners' attitudes toward satisfaction with and quality of learning experiences and increasing learning, instructors should provide more opportunities for learner-to-instructor interaction and learner-to-course content interaction in online course design.

Objective Five: Recommendations

The reliability of the satisfaction, quality, and learning scale was questionable. Adding more items to these scales would be appropriate for future studies, as the additional items in the scale could provide more accurate results to classify factors.

Objective Six: Key Findings

The sixth objective was to explore and describe which technologies in an online learning environment could be a significant predictor of students' satisfaction, perceived quality, and perception of learning increase when interactions are provided during an online learning experience. Several logistic regression analyses were conducted to predict students' attitudes toward satisfaction with online learning experiences, quality

of online learning experiences, and the agreement with increases in learning when four types of interactions were provided in the online course using technologies as predictors.

When learner-to-learner interaction was provided in online courses. Audio/phone calls made a significant contribution to predicting learners' satisfaction with online learning experiences ($p = 0.05$) and learners' agreement that learning increased in the online learning environment ($p = 0.01$) when learner-to-learner interaction was provided in the online course. Audio/phone calls ($p = 0.01$) and collaborative documents ($p = 0.02$) made significant contributions to predicting the quality of online learning experiences when learner-to-learner interaction was provided in the online course.

When learner-to-instructor interaction was provided in the online course. Only online editing and feedback ($p = 0.04$) made a significant contribution to prediction of the satisfaction of online learning experiences when learner-to-instructor interaction was provided in the online course.

When learner-to-course content interaction was provided in the online course. Support materials ($p = 0.05$), online practice exercises ($p = 0.03$), and podcasting ($p = 0.05$) made significant contributions to predicting learners' satisfaction with online learning experiences when learner-to-course content interaction was provided in the online course. Case studies ($p = 0.02$) and podcasting ($p = 0.04$) made significant contributions to prediction of the quality of online learning experiences when learner-to-learner interaction was provided in the online course. Only case studies ($p = 0.01$) made

a significant contribution to predicting learners' agreement that learning increased when learner-to-course content interaction was provided in the online course.

When learner-to-course technology interaction was provided in the online course. Only apps made a significant contribution to predicting learners' satisfaction with online learning experiences ($p = 0.01$), the quality of online learning experiences ($p = 0.02$), and learners' agreement that learning increased ($p = 0.02$) when learner-to-course technology interaction was provided in the online course.

Objective Six: Conclusions

When learner-to-learner interaction was provided in the online course. Only audio/phone calls was a significant predictor for learners' satisfaction with online learning experiences and learners' attitudes toward learning increases when learner-to-learner interaction was provided in the online course. Audio/phone calls and collaborative documents were significant predictors for the quality of the online learning experiences when learner-to-learner interaction was provided in an online course.

Participants who preferred to use audio/phone calls to enhance learner-to-learner interaction were 1.37 times more likely to have higher satisfaction with their online learning experiences than others and 1.52 times more likely to have a positive attitude toward the quality of their online learning experiences than others. However, participants who preferred to use collaborative documents to enhance learner-to-learner interaction were only 0.67 times more likely to have a positive attitude toward the quality of their online learning experiences. Finally, participants who preferred to use audio/phone calls

to enhance learner-to-learner interaction were 1.56 times more likely to agree that learner-to-learner interaction was an effective factor to increase learning in an online course.

When learner-to-instructor interaction was provided in the online course. Only online editing and feedback was a significant predictor for learners' satisfaction with online learning experiences when learner-to-instructor interaction was provided in the online course. Participants who preferred to use online editing and feedback to enhance learner-to-instructor interaction were 0.42 times more likely to have higher satisfaction with their online learning experiences.

Based on results of logistic regression analysis, lecture, video, email, voice-over PowerPoint, online editing and feedback, audio/phone calls, and evaluation were not significant predictors for students' attitudes toward quality of the online learning experience and students' attitude toward increases in learning when learner-to-instructor interaction was provided in the online learning.

When learner-to-course content interaction was provided in the online course. Support materials, online practice exercises, and podcasting were significant predictors for learners' satisfaction of online learning experiences when learner-to-course content interaction was provided in the online course. Case studies and podcasting were significant predictors for quality of online learning experiences when learner-to-learner interaction was provided in the online course. Further, case studies was the only significant predictor for participants' agreement that learning increased when learner-to-course content interaction was provided in an online course.

Participants who preferred to use support materials and podcasting to enhance learner-to-course content interaction were only 0.2 and 0.3 times more likely to have higher satisfaction with their online learning experiences than other participants. Participants who preferred to use online practice exercises to enhance learner-to-course content interaction were 3.34 times more likely to have higher satisfaction with their online learning experiences than others. Participants who preferred to use case studies to enhance learner-to-course content interaction were 2.65 times more likely to have a positive attitude toward the quality of their online learning experiences than others. However, participants who preferred to use podcasting to enhance the learner-to-learner interaction were only 0.38 times more likely to have a positive attitude toward the quality of their online learning experiences than others. Participants who preferred to use case studies to enhance learner-to-course content interaction were 3.05 times more likely to have a positive attitude toward increases in learning in the online course than others.

When learner-to-course technology interaction was provided in the online course. Only apps was a significant predictor for participants' satisfaction with online learning experiences, quality of online learning experiences, and participants' agreement that learning increased when learner-to-course technology interaction was provided in an online course. Participants who preferred to use apps to enhance learner-to-course technology interaction were 1.55 times more likely to have higher satisfaction with their online learning experiences than others. Participants who preferred to use apps to enhance learner-to-course technology interaction were 1.45 times more likely to have a positive attitude toward quality of their online learning experiences than others.

Participants who preferred to use apps to enhance learner-to-course technology interaction were 1.46 times more likely to have a positive attitude toward increases in learning in online courses than others.

Objective Six: Implications

To predict participants' satisfaction with online learning experiences and increases in learning in the online learning environment when learner-to-learner interaction is provided in an online course, instructors can use audio/phone calls. Instructors can use both audio/phone calls and collaborative documents as significant predictors of students' agreement with quality of online learning experiences when learner-to-learner interaction is provided in an online course. Instructors can use online editing and feedback as a predictor of students' satisfaction with online learning experiences when learner-to-instructor interaction is provided in the online course.

To predict students' satisfaction with online learning experiences when learner-to-course content interaction is provided in the online course, instructors can use support materials, online practice exercise, and podcasting. Instructors can use case studies and podcasting as significant predictors for students' agreement with the quality of online learning experiences when learner-to-course content interaction is provided in the online course. To predict students' agreement with increased learning in the online learning environment when learner-to-course content interaction is provided, instructors can use podcasting. Instructors can use apps as a significant predictor for students' satisfaction with online learning experiences, the quality of online learning experiences, and

increased learning in the online learning environment when learner-to-course technology interaction is provided. These results are consistent with earlier findings showing that technologies could be effective predictors to predict students' perceptions of satisfaction, quality, and learning in the online learning environments (Gunawardena et al., 2010; Song et al., 2004).

Objective Six: Recommendations

More research is needed to examine the following questions: (1) why were audio/phone calls a significant predictor of satisfaction with online learning experiences?; (2) why were audio/phone calls and collaborative documents a significant predictors of agreement with the quality of online learning experiences when learner-to-learner interaction was provided in the online course?; (3) why were online editing and feedback a significant predictor of satisfaction of online learning experiences when learner-to-instructor interaction was provided in an online course?; (4) why were support materials, online practice exercise, and podcasting significant predictors of learners' satisfaction with online learning experiences when learner-to-course content interaction was provided in an online course?; (5) why were case studies and podcasting significant predictors of agreement with the quality of online learning experiences when learner-to-course content interaction was provided in the online course?; (6) why was podcasting the significant predictor of agreement with increased learning in the online learning environment when learner-to-course content interaction was provided?; and (7) why were apps the significant predictor of satisfaction with online learning experiences, the

quality of online learning experiences, and increased learning in the online learning environment when learner-to-course technology interaction provided was in the online course?.

Objective Seven: Key Findings

The seventh objective was to determine and describe students' preferences for technologies used to enhance interactions for online learning. Thirty-one different types of technologies were used to measure students' level of agreement with the question: "Is the use of the following technology an effective means for enhancing interactions with other learners, the instructor, the course content, or the course technology?" The respondents were able to choose multiple responses for each given technology.

Enhance interaction with other learners. The most useful technologies to enhance interaction with other learners were Google Docs (76.5%), Facebook (68.2%), email (65.5%), threaded discussions (59.7%), and audio/phone calls (56.4%). The least effective technologies to enhance interaction with other learners were Pinterest (18.5%), Viber (14.4%), voice-over PowerPoint (14.1%), Line (11.0%), and Quip (10.5%).

Enhance interaction with the instructor. The most useful technologies to enhance interaction with the instructor were email (87.3%), lecture (84.5%), instructor announcements (80.1%), PowerPoint (64.9%), online calendar (47.0%), and voice-over PowerPoint (44.2%). The least effective technologies to enhance interaction with the instructor were Quip (6.1%), WhatsApp (6.1%), Pinterest (4.7%), Viber (3.9%), and Snapchat (2.8%).

Enhance interaction with course content. The most useful technologies to enhance interaction with course content were text/textbook (76.2%), PowerPoint (75.1%), online quizzes (73.2%), lecture (69.9%), case studies (66%), and online tutorials (63.3%). The least effective technologies to enhance interaction with course content were WhatsApp (6.6%), Instagram (6.1%), Twitter (5.2%), Snapchat (4.1%), and Viber (2.8%).

Enhance interaction with course technology. The most useful technologies to enhance interaction with course technology were getting help online (51.1%), online tutorials (46.4%), YouTube (43.9%), online quizzes (42.3%), and PowerPoint (41.4%). The least effective technologies to enhance interaction with course technology were Quip (13.5%), WhatsApp (13.3%), worksheets (13.0%), Viber (11.0%), and Line (10.2%).

Objective Seven: Conclusions

Based on these results, the most useful technologies to enhance interaction with other learners were Google Docs, Facebook, email, threaded discussions, and audio/phone calls. The least effective technologies to enhance interaction with other learners were Pinterest, Viber, voice-over PowerPoint, Line, and Quip. To enhance interaction with the instructor, email, lecture, instructor announcements, PowerPoint, online calendar, and voice-over PowerPoint were the most useful technologies, and the least effective technologies to enhance interaction with the instructor were Quip, WhatsApp, Pinterest, Viber, and Snapchat.

The most useful technologies to enhance interaction with course content were text/Textbook, PowerPoint, online quizzes, lecture, case studies, and online tutorial. The least effective technologies to enhance interaction with course content were WhatsApp, Instagram, Twitter, Snapchat, and Viber. To enhance interaction with course technology, getting help online, online tutorials, YouTube, online quizzes, and PowerPoint were the most useful technologies, and the least effective technologies for this interaction were Quip, WhatsApp, worksheets, Viber, and Line.

Objective Seven: Implications and Recommendations

The results suggest that instructors should use Google Docs, Facebook, email, threaded discussions, and audio/phone calls to enhance learner-to-learner interaction in online courses. The results also revealed that instructors should evaluate the use of Pinterest, Viber, voice-over PowerPoint, Line, and Quip in online course design for enhancing learner-to-learner interaction. The findings supported Dooley et al. (2005) and Moore's (1989) conclusions that online chats, email, audio/phone call, social sites, instant messaging, and collaborative documents are examples of effective technologies to enhance learner-to-learner interaction.

To improve interaction with the instructor, instructors could use email, lecture, instructor announcements, PowerPoint, online calendar, and voice-over PowerPoint in the online course. However, the instructors should evaluate the use of Quip, WhatsApp, Pinterest, Viber, and Snapchat to enhance learner-to-instructor interaction in the online learning environments. The findings supported Dooley et al. (2005) and Moore's (1989)

conclusion that lectures, email, and voice-over PowerPoint were recommended technologies to enhance learner-to-instructor interaction.

The results suggest that instructors should explore using text/textbook, PowerPoint, online quizzes, lecture, case studies, and online tutorial to enhance learner-to-course content interaction in the online course. The results also revealed that instructors should evaluate their use of WhatsApp, Instagram, Twitter, Snapchat, and Viber in online course design to enhance learner-to-course content interaction. The findings supported Dooley et al. (2005) and Moore's (1989) conclusions that text/textbooks, worksheets, case studies, PowerPoints, interactive video, online exercises, and collaborative documents were examples of effective technologies to enhance learner-to-course content interaction.

To improve interaction with course technology, instructors could utilize getting help online, online tutorials, YouTube, online quizzes, and PowerPoint in their online courses. Alternatively, the instructors should evaluate use of Quip, WhatsApp, worksheets, Viber, and Line to enhance learner-to-course technology interaction. Instructors must consider using technologies in the online course to create a helpful and appropriate teaching setting. The findings supported Dooley et al. (2005) and Moore's (1989) conclusion that online tutorials, help modules, and a file management system were effective technologies to improve learner-to-course technology interactions in the online courses.

Objective Eight: Key Findings

The eighth objective was to examine the relationship between students' selected personal characteristics and preference for technologies to enhance interactions in online learning. Several independent-samples t-tests were conducted to compare participants' preferences for technology to enhance learner-to-learner interaction, learner-to-instructor interaction, learner-to-course content interaction, and learner-to-course technology interaction when compared in paired groups of male and female, upper and lower classifications, non-science and science majors, and high and low GPA scores.

Differences between genders. There was no significant difference between male and female participants' preferences for technology to enhance learner-to-learner interaction. However, there were significant differences between males' and females' preferences for lecture ($p = 0.02$) and online editing and feedback ($p = 0.01$) to enhance learner-to-instructor interaction, podcasting ($p = 0.05$) to enhance learner-to-course content interaction, and file management systems to enhance learner-to-course technology interaction ($p = 0.04$).

Differences between upper and lower classifications. There was no significant difference between upper classifications and lower classifications in their preferences for technology that can enhance learner-to-learner interaction, learner-to-instructor interaction, learner-to-course content interaction, and learner-to-course technology interaction.

Differences between non-science and science majors. There were significant differences between non-science major participants' and science major participants'

preferences for instant messaging (p = 0.05) and collaborative documents (p = 0.01) to enhance learner-to-learner interaction; lecture (p = 0.04) and audio/phone calls (p = 0.032) to enhance learner-to-instructor interaction; and text/textbooks (p =0.03), support materials (p = 0.01), case studies (p = 0.01), PowerPoint (p = 0.01), interactive video (p = 0.01), online practice exercise (p = 0.01), and collaborative documents (p = 0.01) to enhance learner-to-course content interaction. Finally, there was no significant difference between non-science majors and science majors in their preferences for technologies that can enhance learner-to-course technology interaction.

Differences between high and low GPA. There was no significant difference between high GPA and low GPA in preferences for technology to enhance learner-to-learner interaction, learner-to-instructor interaction, learner-to-course content interaction, and learner-to-course technology interaction.

Objective Eight: Conclusions

Differences between genders. There were no significant differences between males' and females' preferences for email, audio/phone calls, social media, instant messaging, blogging, and collaborative documents to enhance learner-to-learner interaction. However, there was a significant difference in the preferences for lecture and online editing and feedback to enhance learner-to-instructor interaction between the two groups. These results suggest that males have greater preference than females to use lecture to enhance learner-to-instructor interaction in their online learning. Females have greater preference than males for online editing and feedback as an effective technology

to enhance learner-to-instructor interaction in their online learning. Specifically, results suggest that instructors can provide more opportunities to enhance learner-to-instructor interaction for males by using lecture and for females by using online editing and feedback in online courses.

There was a significant difference in male and female preferences for podcasting to enhance learner-to-course content interaction. These results suggest that females have greater preference than males for podcasting to enhance learner-to-course content interaction in their online learning. Specifically, results suggest that instructors can provide more opportunities for females to enhance the learner-to-course content interaction by using podcasting in online courses.

Additionally, there was a significant difference in preferences for file management systems to enhance learner-to-course technology interaction between males and females. These results suggest that females have greater preference than males for the use of file management systems to enhance learner-to-course technology interaction in their online learning. Specifically, results suggest that instructors can provide more opportunities to females to enhance learner-to-course technology interaction by using file management systems in online courses.

Differences between upper and lower classifications. To examine the relationship between participants' classifications and preferences for technology to enhance interactions, this study divided participants into two groups by upper and lower classification. The two groups were as follows: upper classification included participants

who were juniors or seniors, and lower classification included participants who were freshmen or sophomores.

There was no significant difference between upper and lower classifications in their preferences for email, audio/phone calls, social media, instant messaging, blogging, and collaborative documents to enhance learner-to-learner interaction. There was no significant difference between upper and lower classifications in their preferences for lecture, video, email, voice-over PowerPoint, online editing and feedback, audio/phone calls, and evaluation to enhance learner-to-instructor interaction. There was no significant difference between upper and lower classifications in their preferences for text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercise, podcasting, and collaborative documents to enhance learner-to-course content interaction. Finally, there was no significant difference between upper and lower classifications in their preferences for online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, apps, file management systems, and search engines to enhance learner-to-course technology interaction.

Differences between non-science and science majors. To examine the relationship between participants' majors and their preferences for technology that can enhance interactions, participants were divided into two groups by major: non-science majors and science majors. The non-science majors group included participants whose majors were in the following departments: Agricultural Economics; Agricultural Leadership, Education, and Communications; and Recreation, Park and Tourism Science. The science majors group included whose majors were in the following

departments: Animal Science, Biochemistry and Biophysics, Biological and Agricultural Engineering, Ecosystem Science and Management, Entomology, Horticultural Sciences, Nutrition and Food Science, Plant Pathology and Microbiology, Poultry Science, Soil and Crop Sciences, and Wildlife and Fisheries Sciences.

There was a significant difference in students' preferences for instant messaging and collaborative documents to enhance learner-to-learner interaction between non-science majors and science majors. These results suggest that science majors have greater preference than non-science majors for the use of instant messaging and collaborative documents to enhance learner-to-learner interaction in online learning. Specifically, results suggest that instructors can provide more opportunities to enhance learner-to-learner interaction for students in science majors by using instant messaging and collaborative documents in online courses.

There was a significant difference in preferences for lecture and audio/phone calls to enhance learner-to-instructor interaction between non-science majors and science majors. These results suggest that students in the science majors have greater preference than students in the non-science majors for the use of lecture to enhance learner-to-instructor interaction in online learning; also, students in non-science majors have greater preference than science major students for the use of audio/phone calls to enhance learner-to-instructor interaction in online learning. Specifically, results suggest that instructors could provide more opportunities to enhance learner-to-instructor interaction for students in science majors by using lecture and for students in non-science majors by using audio/phone calls in online courses.

There was a significant difference in preferences for text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercise, and collaborative documents to enhance learner-to-course content interaction between non-science majors and science majors. These results suggest that students in the science majors have greater preference than students in the non-science majors for using text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercise, and collaborative documents to enhance learner-to-course content interaction in online learning. Specifically, our results suggest that instructors could provide more opportunities enhance the learner-to-course content interaction to students in the science majors by using text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercise, and collaborative documents in online courses.

There was no significant difference between non-science majors' and science majors' preferences for online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, apps, file management systems, and search engines to enhance learner-to-course technology interaction.

Differences between high GPA and low GPA. To examine the relationship between participants' GPA and their preferences for technology to enhance interactions, participants were divided into two groups by GPA. The high GPA group included participants' whose GPA ranged from 3.0 to 4.0, and the low GPA group included participants with a reported GPA at or below 2.9.

There were no significant differences between high GPA and low GPA groups in their preferences for email, audio/phone call, social media, instant messaging, blogging, and collaborative documents to enhance learner-to-learner interaction. There were also no significant differences between high GPA and low GPA groups in their preferences for lecture, video, email, voice-over PowerPoint, online editing and feedback, audio/phone calls, and evaluation to enhance learner-to-instructor interaction. Thirdly, there were no significant differences between high GPA and low GPA groups' preferences for text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercise, podcasting, and collaborative documents to enhance learner-to-course content interaction. Finally, there were no significant differences between high GPA and low GPA groups' preferences for online tutorials, getting help online, online instructions for downloading plugins, electronic libraries, apps, file management systems, and search engines to enhance learner-to-course technology interaction.

Objective Eight: Implications

Differences between genders. The results indicate that gender may not be not a significant influencing factor on participants' preferences for technology to enhance learner-to-learner interaction. However, instructors can develop additional opportunities to enhance learner-to-instructor interaction for male students by using lecture and more opportunities for female students by using online editing and feedback in online courses. The results also suggest that instructors could provide more opportunities for female

students to use podcasting in online courses to enhance their learner-to-course content interaction. To provide female students with enhanced learner-to-course technology interaction, instructors could increase or begin using file management systems in online courses. These results are consistent with earlier findings showing that gender may be a factor that influence students reaching success in an online course (Volery & Lord, 2000).

Differences between upper and lower classifications. The results indicate that classification is not a significant factor that influences participants' preferences for technology to enhance learner-to-learner, learner-to-instructor, learner-to-course content, and learner-to-course technology interaction.

Differences between non-science and science majors. Results suggest that instructors should provide more opportunities to enhance learner-to-learner interaction for students in the science majors by using instant messaging and collaborative documents in online courses. To improve learner-to-instructor interaction for science major students, instructors could develop more opportunities by using lecture. For non-science major students, instructors can provide more opportunities by using audio/phone calls in online courses to enhance learner-to-instructor interaction. The results also suggest that instructors can provide more opportunities to enhance learner-to-course content interaction for science majors by using text/textbooks, support materials, case studies, PowerPoint, interactive video, online practice exercise, and collaborative documents in online courses. However, the results indicate that learners' majors may not

be not an influencing factor on participants' preferences for technology to enhance learner-to-learner interaction.

Differences between high GPA and low GPA. The results suggest that GPA may be not a significant factor that influences participants' preferences for technology that enhances learner-to-learner, learner-to-instructor, learner-to-course content, and learner-to-course technology interaction.

Objective Eight: Recommendations

More research is needed to study the following unanswered questions: (1) why did male students have a higher preference for using lecture and online editing and feedback systems to enhance learner-to-instructor interaction than female students in an online course?; (2) why did female students have a higher preference for using podcasting to enhance learner-to-course content interaction than male students in an online course?; (3) why did female students have a higher preference for using file management systems to enhance learner-to-course technology interaction than male students in the online course?; (4) why did science major students have a higher preference for using instant messaging and collaborative documents to enhance learner-to-learner interaction than non-science major students in an online course?; (5) why did science major students have a higher preference for using lecture to enhance learner-to-instructor interaction than non-science major students in an online course?; (6) why did non-science major students have a higher preference for using audio/phone calls to enhance learner-to-instructor interaction than science major students in an online

course?; and (7) why did science major students have a higher preference for using text/textbook, support materials, case studies, PowerPoint, interactive video, online practice exercises, and collaborative documents to enhance learner-to-course content interaction than non-science major students in an online course?.

Objective Nine: Key Findings

The ninth objective of this study was to examine the relationship between students' selected personal characteristics and students' satisfaction, perceived quality, and perception of learning increase when interactions are provided during an online learning experience. Several independent-samples t-tests were conducted to compare participants' attitudes toward satisfaction with and quality of online learning experiences and learning increase when four types of interactions were provided in an online course between paired groups of male and female, upper and lower classifications, non-science and science majors, and high and low GPA.

Differences between genders. There was a significant difference between male and female ($p = 0.03$) participants related to increase in satisfaction of a learning experience when learner-to-instructor interaction was provided in the online course.

Differences between upper and lower classifications. There was a significant difference between upper and lower classifications ($p = 0.04$) in that the satisfaction of a learning experience increased when learner-to-instructor interaction was provided in the online course. Also, there was a significant difference between upper and lower

classifications ($p = 0.01$) in the perception of increased quality of a learning experience when learner-to-course content interaction was provided in the online course.

Differences between non-science and science majors. There was no significant difference between non-science major students and science major students in their attitudes toward satisfaction with and quality of the online learning experiences, and learning increase when four types of interactions were provided in an online course.

Differences between high GPA and low GPA. There was a significant difference between high GPA students and low GPA students ($p = 0.02$) in that the quality of a learning experience increased when learner-to-instructor interaction was provided in the online course.

Objective Nine: Conclusions

The results show that males have greater agreement than females that the satisfaction of a learning experience increased when learner-to-instructor interaction was provided in an online course. For upper and lower classifications, the results indicated that upper classification students have greater agreement than lower classification students that the satisfaction of a learning experience increased when learner-to-instructor interaction was provided and the quality of a learning experience increased when learner-to-course content interaction was provided in the online course. However, there was no significant difference between non-science major students and science major students in their attitudes toward satisfaction with and quality of online learning experiences, and the increase in learning when four types of interactions were provided

in an online course. For high GPA and low GPA groups of students, the results show that high GPA students have greater agreement than low GPA students that the quality of a learning experience increased when learner-to-instructor interaction was provided in an online course.

Objective Nine: Implications

Results suggest that instructors could enhance males' satisfaction with a learning experience in the online course by providing more learner-to-instructor interaction opportunities. When males received more learner-to-instructor interaction in the online course, they were more likely to have higher satisfaction with online learning experiences. Specifically, results suggest that instructors could provide more learner-to-instructor interaction opportunities for males to enhance their satisfaction of the learning experience in an online course.

For upper classification students, the results suggest that instructors should provide more learner-to-instructor interaction opportunities to upper classification students to enhance the satisfaction of a learning experience and provide more learner-to-course content interaction opportunities to enhance the quality of a learning experience in online courses. When upper classification students have adequate learner-to-instructor and learner-to-course content interaction in online courses, they may have greater agreement with satisfaction and quality of the online learning experiences. Specifically, results suggest that instructors can provide more learner-to-instructor interaction opportunities to upper classification students to enhance the satisfaction with

a learning experience and provide more learner-to-course content interaction opportunities to upper classification students to enhance the quality of a learning experience in the online courses.

The results also suggest that instructors could provide additional learner-to-instructor interaction opportunities for high GPA students to increase the quality of learning experiences in online courses. When high GPA students receive learner-to-instructor interaction in online courses, they were more likely to have greater agreement with the quality of the online learning experiences. Specifically, our results suggest that instructors should provide more learner-to-instructor interaction opportunities for high GPA students to increase the quality of learning experiences in an online course.

Objective Nine: Recommendations

More research is needed to study the following problems: (1) why did male students have a higher agreement with satisfaction with online learning experiences when learner-to-instructor interactions were provided in an online course?; (2) why did upper classification students have a higher agreement with satisfaction with online learning experiences when learner-to-instructor interactions were provided in an online course?; (3) why did upper classification students have a higher agreement with quality of online learning experiences when learner-to-course content interactions were provided in an online course?; and (4) why did high GPA students have a higher agreement with quality of online learning experiences when learner-to-instructor interactions were provided in an online course?.

Implications and Recommendations for Practice

Technology Use may be an Important Factor to Students in An Online Course

According to the findings of this study, there are some significant relationships between interactions of Moore's (1989) transactional distance theory and technology use in an online course. The results showed that different types of technology may have different influences on students to enhance interactions with other learners, with the instructor, with course content, and with course technology in online learning environments. Different types of interaction may also have different influences on students' attitudes toward their satisfaction with online learning experiences, the quality of online learning experiences, and increased learning in online learning environments. These results are consistent with earlier findings showing that learners who perceived more interactions in the online course may have higher satisfaction and increased learning and engagement with online learning (Jung et al., 2002; Moore, 1993; Ni, 2013).

Students' Perceptions of Satisfaction, Quality, and Leaning are Influenced by the Technologies and Interactions

From the results of this study, multiple technologies can be significant predictors of students' perceptions of satisfaction, quality, and learning related to an online learning experience in an online course. According to Table 63, instructors can use the following technologies when learner-to-learner interaction, learner-to-instructor interaction, learner-to-course content interaction, and learner-to-course technology interaction are

provided in the online course to predict learners' satisfaction, quality, and learning related to the online learning experience. These results are also consistent with earlier findings showing that using diverse technologies in an online course could enhance learners' perceptions of satisfaction, quality, and learning in online learning environments (Gunawardena et al., 2010; Wang, 2007).

Table 63
Summary of Students' Preferences toward Technology to Enhance Their Perceptions of Satisfaction, Quality, and Leaning in an Online Course When Diverse Interactions were Employed

Interactions	Satisfactions	Quality	Learning
With Other Learner	Audio/phone call.	Audio/phone call & Collaborative documents.	Audio/phone call.
With the Instructor	Online editing and feedback.	N/A.	N/A.
With the Course content	Support materials, online practice, & Podcasting.	Case studies & Podcasting.	Case studies.
With the Course technology	Apps.	Apps.	Apps.

When learner-to-learner interaction is provided in online course design, instructors can use audio/phone calls as the main predictor of learners' perceptions of satisfaction, quality, and learning in the online courses. Online editing and feedback is the only significant technology to predict learners' perceptions of satisfaction in the online courses when learner-to-instructor interaction was provided. Thus, instructors can use online editing and feedback to enhance learners' satisfaction when learner-to-instructor interaction are provided in the online courses.

Several technologies are significant predictors that instructors can use in the online course to enhance learners' satisfaction, quality, and learning when learner-to-course content interactions are provided. The results of this study show that case study is one significant technology that can predict learners' perceptions of quality and learning in online courses. However, there are some concerns pertaining to instructors using case studies in course design. First, it can be difficult for instructors to identify appropriate case studies, especially if no case studies exist for a topic. Second, some instructors have limited class time available and would be required to utilize some of this time to prepare to use case studies in class (Tham & Tham, 2013). Before the class meets, instructors must locate a case study and fully understand the case. During the class, instructors will lead students in discussions and share ideas related to the case study so that students can make connections between the case studies and the course content. In addition, if classes only meet for a limited time period, both instructors and students may not have sufficient time to read and discuss case studies in class. Therefore, even though case studies are a significant technology that can be used to enhance students' perceptions of quality and learning within online learning, instructors should consider practical implications.

Apps are the only significant technology to predict learners' perceptions of satisfaction, quality, and learning in an online course when learner-to-course technology interaction was provided. Instructors can use a variety of apps in an online course to enhance learners' satisfaction, quality, and learning. However, there are some concerns instructors should consider when using apps in online courses. First, instructors may not be able to locate existing appropriate apps that would fit the course's needs. Second,

some usable apps may require a fee for use, which may be a limitation for students who are unwilling or unable to purchase the app for learning. Third, some types of apps can only be used for certain systems or devices. For example, some apps are only designed for the iOS system and not for Android system. If students do not own an iOS-enabled device, they may be unable to use that app to learn.

Learners' Characteristics May Influence Learners' Attitudes toward Technology Use in an Online Course

Volery and Lord (2000) revealed that technology, instructor characteristics, and students' characteristics are three main factors that may influence the effectiveness of online learning. The results of this study indicate that student characteristics such as gender and major may also be important factors that can influence learners' attitudes toward technology use in an online course. Specifically, this study noted numerous differences between students in science majors and students in non-science majors' attitudes toward technologies to enhance interactions in an online course.

Recommendations for Research

Methodology

This study used quantitative research methods to examine learners' perceptions of technology use to enhance learner-to-learner, learner-to-instructor, learner-to-course content, and learner-to-course technology interaction in an online course. Use of the qualitative research method or mixed research method is recommended for future studies

to explore why a specific technology is a more or less preferred tool for students to enhance interactions in online courses. Researchers could compare learners' changes in satisfaction or learning performance after using specific technologies in an online course through pre-test and post-test, classroom observations, individual interviews, and other research methods. The interview method is specifically recommended for future studies to encourage a better understanding of learners' personal experiences of and perceptions toward technology use in the online course environment to enhance interactions. The classroom observation method is also recommended for future studies in order to examine and explore the improvements in learner engagement and participation in online learning when specific technology or interactions are provided in the online course.

Instrument Scales and Instrument Design

Reliability analysis of the study instrument related to the learner-to-instructor interaction scale and the satisfaction, quality, and learning scale were questionable. There are two methods that could be used in future studies to improve the reliability of these two scales. The first method would be to add additional items or questions to the learner-to-instructor interaction scale and the satisfaction, quality, and learning scale to increase the reliability. Another method would be to repeatedly test the reliability of instrument before conducting formal research. Doing several pilot studies and consequently revising the instrument would be a way to ensure the reliability of the instrument.

Regarding instrument design, it is recommended to add additional questions regarding learners' personal online learning experience in the beginning of the instrument. The following questions should be considered for addition: How many online courses have you taken?, How would you describe the online course that you had taken?, and, What types of technologies were used in the online course? Data gathered from a series of questions related to students' personal online learning experiences would help researchers greatly strengthen their understanding of their target population. Also, the more online learning experiences a respondent has, the higher possibility that she/he is able to express more accurate perceptions toward technology. To measure learners' perceptions of satisfaction, quality, and learning in regard to online learning experiences, it is recommended that the scale be expanded from "agree or disagree," two-point scales, to a five-point Likert-type scale. The five-point Likert-type scale would allow students to express different levels of agreement about their perceptions of satisfaction, quality, and learning in regard to online learning experiences. Researchers and instructors could use these scales to explore differences among students.

Population

The population of this study was limited to College of Agriculture and Life Science undergraduate students at Texas A&M University. The sample size of this study may not represent the whole population's differences between genders and majors. For future studies, researchers suggest surveying additional populations to explore students' preferences for technology use and the influence of technology on interactions in online

learning environments. For example, a future study could simply focus on gender, major, education level, or GPA to compare learners' attitudes toward specific technology use to enhance interactions in an online course. For majors, a future study could explore differences between students in science majors and students in social science majors. For example, the population of a study would extend to include students in the College of Engineering, the College of Architecture, the College of Education and Human Development, the College of Geosciences, and the College of Liberal Arts. The future study could use the variety of majors to explore and compare students' attitudes toward technology use in online learning environments for different subjects. According to the results of this study, there was no difference between students in different classifications or with low or high reported GPA scores. For classification, a future study could compare students with different education levels such as senior high school students, bachelor degree students, master degree students, or doctoral degree students. In regards to GPA, a future study could compare high achievement students' and low achievement students' preferences for technology use in an online course to enhance learning.

Students' Online Learning Experiences

Participants' diverse online learning experiences may be a limitation for the results of this study. Song et al. (2004) indicated that learners' experiences of technology use in online courses are an important factor that influences learners' attitudes toward the effectiveness of technology use in online courses. Each participant may have unique online learning experiences, and not all participants in this study had previous online

experiences with equal quality. Even if participants were from the same departments, the online course design, frequency of online course participation, and technology use in the online course may vary from course to course.

Students who have had unpleasant online learning experiences in the past may tend to feel that some technologies used in the online class are not able to enhance their learning. Students with a greater number of online learning experiences may provide more accurate opinions. Students who have had only one or two online learning experiences may have a limited ability to provide accurate answers about technology use to enhance interactions in an online course. Hence, participants' diverse online learning experiences may be a substantial limitation. For future studies, researchers should focus on populations who are currently enrolled in an online course and provide specific technologies to students to explore their attitudes toward technology use to enhance interactions in an online course.

Specific Research Questions

Additional research is recommended to answer the following questions:

1. Why do learners disagree with the usage of blogging to enhance learner-to-learner interaction in an online course?
2. Why do learners neither agree nor disagree with the usage of voice-over PowerPoint and audio/phone calls to enhance learner-to-instructor interaction in an online course?

3. Why do learners disagree with the usage of podcasting to enhance learner-to-course content interaction in an online course?
4. Why do learners disagree with the usage of online instructions for downloading plugins to enhance learner-to-course technology interaction in an online course?
5. Why might feedback tools, sonic interaction tools, and learner-to-instructor interaction tools influence learners' attitudes toward the effectiveness of technology use to enhance learner-to-instructor interaction in an online course?
6. Why might active learning tools and reading tools influence learners' attitudes toward the effectiveness of technology use to enhance learner-to-course content interaction in an online course?
7. Why could using lecture be an effective technology for students to enhance interaction with other learners in an online course?
8. Why could using PowerPoint and Google Docs be an effective technology for students to enhance interaction with the course technology in an online course?
9. Why was audio/phone calls a significant predictor of learners' satisfaction of online learning experiences and increased learning in the online learning environment when learner-to-learner interaction was provided in an online course?
10. Why were audio/phone calls and collaborative documents significant predictors of learners' agreement with the quality of online learning experiences when learner-to-learner interaction was provided in an online course?

11. Why was online editing and feedback the significant predictor of learners' satisfaction with online learning experiences when learner-to-instructor interaction was provided in an online course?
12. Why were support materials, online practice exercise, and podcasting the significant predictors of learners' satisfaction with online learning experiences when learner-to-course content interaction was provided in an online course?
13. Why were case studies and podcasting the significant predictors of learners' agreement with the quality of online learning experiences when learner-to-course content interaction was provided in an online course?
14. Why was podcasting the significant predictor of learners' agreement with increased learning in the online learning environment when learner-to-course content interaction was provided in an online course?
15. Why were apps the significant predictor of learners' satisfaction of online learning experiences, the quality of online learning experiences, and increased learning in the online learning environment when learner-to-course technology interaction was provided in an online course?
16. Why do male students have a higher preference for using lecture and online editing and feedback systems to enhance learner-to-instructor interaction than female students in an online course?
17. Why do female students have a higher preference for using podcasting to enhance learner-to-course content interaction than male students in an online course?

18. Why do female students have a higher preference for using file management systems to enhance learner-to-course technology interaction than male students in an online course?
19. Why do science major students have a higher preference for using instant messaging and collaborative documents to enhance learner-to-learner interaction than non-science major students in an online course?
20. Why do science major students have a higher preference for using lecture to enhance learner-to-instructor interaction than non-science major students in an online course?
21. Why do non-science major students have a higher preference for using audio/phone calls to enhance learner-to-instructor interaction than science major students in an online course?
22. Why do science major students have a higher preference for using text/textbook, support materials, case studies, PowerPoint, interactive video, online practice exercises, and collaborative documents to enhance learner-to-course content interaction than non-science major students in an online course?
23. Why do male students express a higher satisfaction with online learning experiences when learner-to-instructor interactions are provided in an online course?
24. Why do students classified as seniors express a higher satisfaction with online learning experiences when learner-to-instructor interactions are provided in an online course?

25. Why do students classified as seniors express a higher quality of online learning experiences when learner-to-course content interactions were provided in an online course?
26. Why do high GPA students express a higher quality of online learning experiences when learner-to-instructor interactions were provided in an online course?
27. Does gender, classification, major, or GPA serve as significant factors to influence learners' attitudes toward technology use to enhance interactions in an online course?
28. Does gender, classification, major, or GPA serve as significant factors to influence learners' attitudes toward satisfaction with and quality of online learning experiences and increased learning in online learning when interactions were provided in an online course?
29. What other characteristics might be factors to influence students' attitudes toward technology use to enhance interactions in an online course?
30. What other characteristics might be factors that influence students' attitude toward satisfaction with and quality of online learning experiences and increased learning in online learning when interactions provided in an online course?

Theoretical Contribution

According to the Moore's (1989) transactional distance theory, researchers believed that students can receive maximum satisfaction in an online course when provided four types of interactions (Dooley et al., 2005). Several researchers also pointed out that the variety of interactions is very important to online learners for

successful online learning experiences (Beuchot & Bullen, 2005; Jung et al., 2002; Lin & Berge; 2005; Song et al., 2004; Su et al., 2005). However, we found that learner-to-instructor interaction and learner-to-course content interaction were more important to students to enhance their perceptions of satisfaction, quality, and learning based on findings (Shown in Table 64).

Online learning requires a different kind of learning when compared to traditional face-to-face learning. Students can experience conflict in learning when they switch from face-to-face courses to online courses (Teoh et al., 2013). Hence, online learners may have more need for learner-to-course content interaction to ensure that they learned concepts shared through the online course. In addition, because the instructor and students are physically separated from each other, online learners require interactions with the instructors through technologies for discussing and learning course concepts. Therefore, compared to learner-to-learner interaction and learner-to-course technology interaction, learner-to-course content interaction and learner-to-course instructor interaction are more important for students to be successful in online learning. These results are consistent with earlier findings showing that types of interactions provided in an online course are not equally important to students (Chang, 2013; Kuo, 2014; Jung et al., 2002; Seidel, 2012; Strachota, 2003).

This study documents that it is important to provide all four kinds of interactions in an online course to help students learn in online learning environments. However, if time and resources are limited, it is recommended that instructors focus on providing learner-to-course content interaction and learner-to-instructor interaction.

Table 64

Student Ranking of Level of Importance of Interactions Provided in an Online Course to Enhance Perceptions of Satisfaction, Quality, and Learning

Rank	Satisfaction	Quality	Learning
1	Learner-to-course content interaction	Learner-to-instructor interaction	Learner-to-instructor interaction
2	Learner-to-instructor interaction	Learner-to-course content interaction	Learner-to-course content interaction
3	Learner-to-learner interaction	Learner-to-learner interaction	Learner-to-learner interaction
4	Learner-to-course technology interaction	Learner-to-course technology interaction	Learner-to-course technology interaction

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APPENDIX A-1

SURVEY INSTRUMENT (ENGLISH VERSION FOR TAMU)

Statement of research

The purpose of the research is to describe and compare levels of perceptions and attitude of Taiwanese and American college students in Agriculture towards online learning and multimedia technology; and to understand if using different types of multimedia technology enhance the college students' learning and their interaction with other learners, the instructor, the course content, and the course technology. The questionnaire contains a series of questions related to your experiences of using different types of multimedia technology in an online learning environment and your understanding and perceptions about different types of multimedia technology. Your participation in this study will take 8-12 minutes.

The risk of taking this questionnaire is no greater than any risk you would come across in everyday life. However, you may feel that some questions are annoying or stressful. You do not have to answer those if you don't want to.

If you have questions regarding this study, you may contact Ruei-Ping Chang, PhD student at Texas A&M University, at 979-422-8768 or e-mail: pipikingdom@tamu.edu

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Q1: What is your preference for the course delivery format?

❍ **Face to face course**

❍ **Blended method course** (Include both face to face class and online learning class)

❍ **Online course**

Q2-1: I prefer to take face to face courses because it enhances my engagement _____. (Please choose ALL that apply.) **Display this question, only when the Q1 answer is the face to face course.**

- ❑ with other learners
- ❑ with the instructor
- ❑ with the course content
- ❑ with the course technology

Q2-2: I prefer to take Blended method courses because it enhances my engagement _____. (Please choose ALL that apply.) **Display this question, only when the Q1 answer is the blended method course.**

- ❑ with other learners
- ❑ with the instructor
- ❑ with the course content
- ❑ with the course technology

Q2-3: I prefer to take online courses because it enhances my engagement _____. (Please choose ALL that apply.) **Display this question, only when the Q1 answer is the online course.**

- ❑ with other learners
- ❑ with the instructor
- ❑ with the course content
- ❑ with the course technology

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Section I: Learner to Learner Interactions

Read each statement below and indicate whether you agree or disagree by making the appropriate response.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The use of **"Email"** enhances my interactions with **other learners**.	❍	❍	❍	❍	❍
The use of **"Audio/phone call (e.g. Using Skype, Viber, or Tango)"** enhances my interactions with **other learners**.	❍	❍	❍	❍	❍
The use of **"Social Medias (e.g. Using Facebook, Instgram, LinkedIn, or Google +)"** enhances my interactions with **other learners**.	❍	❍	❍	❍	❍
The use of **"Instant messaging (e.g. Using Text, Whats App, Snapchat, Line, or Facebook Messenger)"** enhances my interactions with **other learners**.	❍	❍	❍	❍	❍
The use of **"Blogging (e.g. Using WordPress, Pinterest, Blogger, or Tumblr)"** enhances my interactions with **other learners**.	❍	❍	❍	❍	❍
The use of **"Collaborative documents (e.g. Using Google docs or Quip)"** enhances my interactions with **other learners**.	❍	❍	❍	❍	❍

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Section II: Learner to Instructor Interactions:

Read each statement below and indicate whether you agree or disagree by making the appropriate response.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The use of "**Lecture**" enhances my interactions with **the instructor**.	❍	❍	❍	❍	❍
The use of "**Video**" enhances my interactions with **the instructor**.	❍	❍	❍	❍	❍
The use of "**Email**" enhances my interactions with **the instructor**.	❍	❍	❍	❍	❍
The use of "**Voice over PowerPoint**" enhances my interactions with **the instructor**.	❍	❍	❍	❍	❍
The use of "**Online editing and feedback**" enhances my interactions with **the instructor**.	❍	❍	❍	❍	❍
The use of "**Audio/phone call (e.g. Using Skype, Viber, or Tango)**" enhances my interactions with **the instructor**.	❍	❍	❍	❍	❍
The use of "**Evaluation**" enhances my interactions with **the instructor**.	❍	❍	❍	❍	❍

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Section III: Learner to Content Interactions:

Read each statement below and indicate whether you agree or disagree by making the appropriate response.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The use of "**Text / Textbooks**" enhances my interactions with **course content**.	❍	❍	❍	❍	❍
The use of "**Support materials (e.g. Providing links or extension reading)**" enhances my interactions with **course content**.	❍	❍	❍	❍	❍
The use of "**Case studies**" enhances my interactions with **course content**.	❍	❍	❍	❍	❍
The use of "**PowerPoint**" enhances my interactions with **course content**.	❍	❍	❍	❍	❍
The use of "**Interactive video**" enhances my interactions with **course content**.	❍	❍	❍	❍	❍
The use of "**Online practice exercises (e.g. online quiz)**" enhances my interactions with **course content**.	❍	❍	❍	❍	❍
The use of "**Podcasting (e.g. Using voice message / record)**" enhances my interactions with **course content**.	❍	❍	❍	❍	❍
The use of "**Collaborative documents (e.g. Using Google docs or Quip)**" enhances my interactions with **course content**.	❍	❍	❍	❍	❍

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Section IV: Learner to Technology Interactions

Read each statement below and indicate whether you agree or disagree by making the appropriate response.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The use of "**Online tutorials**" enhances my interactions with **course technology**.	❍	❍	❍	❍	❍
The use of "**Getting help online**" enhances my interactions with **course technology**.	❍	❍	❍	❍	❍
The use of "**Online instructions for downloading plugins**" enhances my interactions with **course technology**.	❍	❍	❍	❍	❍
The use of "**Electronic libraries**" enhances my interactions with **course technology**.	❍	❍	❍	❍	❍
The use of "**Apps**" enhances my interactions with **course technology**.	❍	❍	❍	❍	❍
The use of "**File management systems (e.g. Using Dropbox or Google Drive)**" enhances my interactions with **course technology**.	❍	❍	❍	❍	❍
The use of "**Search engines (e.g. Using Google, Bing, or Yahoo Search)**" enhances my interactions with **course technology**.	❍	❍	❍	❍	❍

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Section V: Satisfaction, Quality, and Learning

Read each statement below and indicate whether you agree or disagree by making the appropriate response.

	Disagree	Agree
I am generally more satisfied with a learning experience when opportunities for interaction **with other students** are provided.	❍	❍
I am generally more satisfied with a learning experience when opportunities for interaction **with the instructor** are provided.	❍	❍
I am generally more satisfied with a learning experience when opportunities for interaction **with the content** are provided.	❍	❍
I am generally more satisfied with a learning experience when opportunities for interaction **with the technology** are provided.	❍	❍
The quality of a learning experience increase when opportunities for interaction **with other students** are provided**.**	❍	❍
The quality of a learning experience increase when opportunities for interaction **with the instructor** are provided**.**	❍	❍
The quality of a learning experience increase when opportunities for interaction **with the content** are provided**.**	❍	❍
The quality of a learning experience increase when opportunities for interaction **with the technology** are provided**.**	❍	❍
Learning increases when opportunities for interaction **with other students** are provided.	❍	❍
Learning increases when opportunities for interaction **with the instructor** are provided.	❍	❍
Learning increases when opportunities for interaction **with the content** are provided.	❍	❍
Learning increases when opportunities for interaction **with the technology** are provided.	❍	❍

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Section VI: Enhancing interactions I

Is the use of the following technology an effective means for enhancing interactions with other learners, the instructor, the technology, or the content? Choose whether you agree. No response indicates disagreement.

See example below. If you believe that Online Chat can be used to enhance interactions with other learners, the instructor, and content, but not technology, you would respond as shown below. (Please choose **ALL** that apply.)

	With other learners	With the instructor	With the content	With the technology
Example: Online Chat	V	V	V	❑
Audio/ phone call	❑	❑	❑	❑
Blogger	❑	❑	❑	❑
Case studies	❑	❑	❑	❑
Dropbox	❑	❑	❑	❑
Email	❑	❑	❑	❑
Facebook	❑	❑	❑	❑
Getting help online	❑	❑	❑	❑
Google docs	❑	❑	❑	❑
Google +	❑	❑	❑	❑
Instagram	❑	❑	❑	❑

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Enhancing interactions II

Is the use of the following technology an effective means for enhancing interactions with other learners, the instructor, the technology, or the content? Choose whether you agree. No response indicates disagreement.

	With other learners	With the instructor	With the content	With the technology
Instructor announcements	❑	❑	❑	❑
Lecture	❑	❑	❑	❑
Line	❑	❑	❑	❑
LinkedIn	❑	❑	❑	❑
Online calendar	❑	❑	❑	❑
Online tutorials	❑	❑	❑	❑
Online quizzes	❑	❑	❑	❑
Pinterest	❑	❑	❑	❑
PowerPoint	❑	❑	❑	❑
Quip	❑	❑	❑	❑
Role play/ Simulations	❑	❑	❑	❑

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Enhancing interactions III

Is the use of the following technology an effective means for enhancing interactions with other learners, the instructor, the technology, or the content? Choose whether you agree. No response indicates disagreement.

	With other learners	With the instructor	With the content	With the technology
Skype	❑	❑	❑	❑
Snapchat	❑	❑	❑	❑
Text / Textbook	❑	❑	❑	❑
Threaded discussions	❑	❑	❑	❑
Twitter	❑	❑	❑	❑
Viber	❑	❑	❑	❑
Voice over PowerPoint	❑	❑	❑	❑
Whats App	❑	❑	❑	❑
Worksheets	❑	❑	❑	❑
YouTube	❑	❑	❑	❑

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What is your gender?

- ❍ Male
- ❍ Female

Which grade/class are you (in)?

- ❍ Class of 2020
- ❍ Class of 2019
- ❍ Class of 2018
- ❍ Class of 2017
- ❍ Class of 2016

What is your major?

- ❍ Agricultural Economics
- ❍ Agricultural Leadership, Education, and Communications
- ❍ Animal Science
- ❍ Biochemistry & Biophysics
- ❍ Biological and Agricultural Engineering
- ❍ Ecosystem Science and Management
- ❍ Entomology
- ❍ Horticultural Sciences
- ❍ Nutrition and Food Science
- ❍ Plant Pathology and Microbiology
- ❍ Poultry Science
- ❍ Recreation, Park and Tourism Sciences
- ❍ Soil and Crop Sciences
- ❍ Wildlife and Fisheries Sciences

What is your total GPA score?

- ❍ 4.0
- ❍ 3.5-3.9
- ❍ 3.0-3.4
- ❍ 2.5-2.9
- ❍ 2.0-2.4
- ❍ 1.5-1.9
- ❍ 1.0-1.4
- ❍ I have no GPA score now

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APPENDIX A-2

INFORMATION SHEET

Project Title: Comparing and Analyzing attitude and perceptions of Taiwanese and American college students in Agriculture towards online learning and the use of Multimedia technology in learning

You are invited to take part in a research study being conducted by Ruei-Ping Chang, a researcher from the Department of Agricultural Leadership, Education, and Communications (ALEC) at Texas A&M University. The information in this form is provided to help you decide if you want to participate. If you decide to take part in the study, you will be asked to sign this consent form. If you decide you do not want to participate, there will be no penalty to you, and you will not lose any benefits you normally would have.

Why Is This Study Being Done?

There are two purposes of this study: (a) to describe and compare levels of perceptions and attitude of Taiwanese and American college students in Agriculture towards online learning and multimedia technology; and (b) to understand if using different types of multimedia technology enhance the college students' learning and their interaction with other learners, the instructor, the course content, and the course technology.

Why Am I Being Asked To Be In This Study?

You are asked to participate in this study because you are an undergraduate student in the College of Agriculture and Life Sciences at Texas A&M University (TAMU) in the United State of America, or at National Chung-Hsing University (NCHU) in Taiwan.

How Many People Will Be Asked To Be In This Study?

350 college students at NCHU and 370 college students at TAMU will be invited to participate in this study.

What Will I Be Asked To Do In This Study?

You will be invited to participant in this research by receiving a questionnaire via email. The questionnaire contains a series of questions related to (a) your experiences of using different types of multimedia technology in an online learning environment and (b) your understanding and perceptions about different types of multimedia technology. Your participation in this study will take 8-12 minutes.

INFORMATION SHEET

Are There Any Risks To Me?

The risk of taking this questionnaire is no greater than any risk you would come across in everyday life. The researcher has also tried to avoid any potential risks; however, you may feel that some questions are annoying or stressful. You do not have to answer those if you don't want to.

Are There Any Benefits To Me?

Participants can receive better quality online class design in the future by learning with appropriate multimedia technology. Also, participants can choose their favorite type of multimedia technology to assist their online learning.

Will There Be Any Costs To Me?

Aside from your time and energy, there are no costs for taking part in the study.

Will I Be Paid To Be In This Study?

You will not be paid for being in this study.

Will Information From This Study Be Kept Private?

The records of this study will be kept private. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be stored securely and only the researcher will have access to the records.

Information about you will be stored in locked file cabinet; computer files protected with a password. This consent form will be filed securely in an official area.

People who have access to your information include the Principal Investigator. Representatives of regulatory agencies such as the Office of Human Research Protections (OHRP) or *(if FDA regulated)* the Food and Drug Administration (FDA) and entities such as the Texas A&M University Human Subjects Protection Program may access your records to make sure the study is being run correctly and that information is collected properly. Information about you and related to this study will be kept confidential to the extent permitted or required by law.

INFORMATION SHEET

Who may I Contact for More Information?

You may contact the advisor, James R. Lindner to tell him about a concern or complaint about this research at ndann@tamu.edu/ 979-458-2701, or contact the primary investigator, Ruei-Ping Chang at pipikingdom@neo.tamu.edu/979-422-8768.

For questions about your rights as a research participant, to provide input regarding research, or if you have questions, complaints, or concerns about the research, you may call the Texas A&M University Human Subjects Protection Program office by phone at 1-979-458-4067, toll free at 1-855-795-8636, or by email at irb@tamu.edu.

What if I Change My Mind About Participating?

This research is voluntary and you have the choice whether or not to be in this research study. You may decide to not begin or to stop participating at any time. If you choose not to be in this study or stop being in the study, there will be no effect on you.

STATEMENT OF CONSENT

I agree to be in this study and know that I am not giving up any legal rights by signing this form. The procedures, risks, and benefits have been explained to me, and my questions have been answered. I know that new information about this research study will be provided to me as it becomes available and that the researcher will tell me if I must be removed from the study. I can ask more questions if I want. A copy of this entire consent form will be given to me.

INVESTIGATOR'S AFFIDAVIT:

Either I have or my agent has carefully explained to the participant the nature of the above project. I hereby certify that to the best of my knowledge the person who signed this consent form was informed of the nature, demands, benefits, and risks involved in his/her participation.