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ENGAGING STUDENTS ONLINE: THE EFFECTS OF COURSE MODALITY, COMPUTER ANXIETY, AND COMPUTER MEDIATED COMPUTER ANXIETY

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Abstract

Prior research has identified many ways to enhance online student engagement but has not addressed those factors that can diminish online student engagement. This study reviews the existing literature on computer anxiety, computer-mediated communication anxiety, course modality, and online student engagement. With the rapid growth of online education, understanding the factors that inhibit student engagement in online courses is just as important as those that enhance engagement.

Computer anxiety refers to the apprehension or fear experienced by individuals when interacting with computers or technology. Similarly, computer-mediated communication anxiety refers to the anxiety experienced when communicating through digital platforms. Both anxieties can significantly impact online student engagement. While course modality refers to the different formats in which courses are delivered, such as fully online, blended, or face-to-face. The choice of course modality can influence students' comfort levels, motivation, and interaction patterns, thereby affecting their overall engagement.

Surveying an introductory MIS business course during the pandemic, this study found a three-way interaction between course modality, computer anxiety, and computer-mediated communication anxiety. Understanding the dynamics of computer anxiety, computer-mediated communication anxiety, course modality, and online student engagement can guide professors in creating supportive and engaging online learning environments that promote effective student learning and success. Further research and the practical implications of these findings are discussed.

Introduction

Until the spring of 2020, students self-selected into online courses. Extraneous factors such as employment or living arrangements meant that some students who would rather take in person classes took online courses, but it wasn't until March 2020 that universities moved all classes online and there was no other option but to take classes online. A decade ago, research showed that almost one third of college students had taken at least one online course (Allen & Seaman, 2013), and the debate as to whether online courses are as effective as face-to-face (F2F) has long been settled with the preponderance of the research showing that online courses are every bit as effective as F2F courses (Maki & Maki, 2007; Robertson, Grant, & Jackson, 2005; Zhao, Lei, Lai, & Tan, 2005). Since online learning is part of the educational landscape, and with 100% of

all learning having recently been in a mandated online setting, it has become important to understand what enhances or diminishes learning in the online environment (Gaytan & McEwen, 2007; Levy, 2008).

One of the keys to course success is student engagement (Nevid, Keating, & Lieblich, 2022). Student engagement is typically defined as the degree to which students actively engage with course material either by thinking about, talking about, or interacting with course content, other course participants, or the course instructor (Dixson, 2015). Engagement is the primary method for students to stay connected with the course and by extension, their mastery of course material (Nevid et al., 2022; Wammes, Seli, Cheyne, Boucher, & Smilek, 2016). Student engagement lies at the heart of successful learning experiences, regardless of the mode of instruction, but in an online setting, fostering student engagement becomes even more crucial. Engagement can be promoted through various strategies, such as interactive multimedia content, discussion forums, and real-time communication tools (Freedman, Oates, & Kirk, 2021; Patall, Zambrano, Kennedy, Yates, & Vallín, 2022; Ratcliff, Minster, & Monheim, 2021). When students are engaged, they are more likely to invest effort and time in the course, leading to improved performance (Nevid et al., 2022; Wammes et al., 2016). Since engagement is an important ingredient in course success, investigating phenomenon that inhibit or prevent students from engaging with course material is of interest. The following section will review the relevant literature and propose a set of testable hypotheses.

Literature Review

The idea of social construction underpins the conceptualization of student engagement, and this theoretical lens works well when discussing F2F learning. However, when a course is online this social construction lens does not fully explain how engagement leads to success. In an online setting, the more recently developed community of inquiry model helps explain how engagement works in an online course.

Social Construction Theories

Social construction theories argue that individuals construct meaning and knowledge by interacting with others, and this is where student learning occurs (Vygotsky, 1978). In an online course, creating opportunities for social construction is vital. Collaborative learning activities, group projects, and peer feedback sessions foster interaction and dialogue among students. These activities not only deepen understanding but also promote critical thinking, problem-solving skills, and social interaction within a virtual learning community (Freedman et al., 2021; Patall et al., 2022; Ratcliff et al., 2021).

Social construction theories also argue that students learn by observing their peers (Bandura, Ross, & Ross, 1961). This is where the social constructivist theories show their age, meaning they were developed long before the rise of internet communication technologies. In an asynchronous online course, how do students have these opportunities to observe their peers' behaviors? The most common way is via discussion boards, but other ways include group projects, shared wikis, and other collaborative documents. Technology has the capacity to overcome the synchronicity (not being online at the same time) and placedness (not being collocated) barriers (Anderson, 2008; Malpas, 2018), and best practices often call for professors to use

social presence, community, and meaningful interaction to help develop student engagement (Bigatel, Ragan, Kenan, & Redmond, 2012). It is this observable learning aspect of engagement where the community of inquiry model addresses the gaps in the social construction theory.

Community of Inquiry

The Community of Inquiry (CoI) theoretical framework emphasizes the importance of social presence, cognitive presence, and teaching presence in online learning environments (Garrison, Anderson, & Archer, 2000). Social presence involves creating a sense of belonging and interpersonal connections among students. Cognitive presence focuses on the construction of meaning through critical discourse, while teaching presence refers to the facilitation and guidance provided by instructors. CoI frameworks emphasize the importance of these three elements in cultivating meaningful learning experiences in online courses (Daspit & D'Souza, 2012; Maddrell, Morrison, & Watson, 2017; Shea & Bidjerano, 2008). The CoI model was developed to explicitly address the shortcomings of the social constructivist views when focused on an online environment (Shea & Bidjerano, 2008). Its basic premise is that knowledge is constructed through focused interaction within a community of individuals and its three perspectives of presence describe how an online community can form in a virtual environment.

Social Construction & Communities of Inquiry

Social construction and communities of inquiry are mutually reinforcing. When students participate in social interactions, they are contributing to the development of a strong community of inquiry. A vibrant community of inquiry enhances student engagement by providing opportunities for collaboration, discussion, and the exploration of diverse perspectives. Instructors play a pivotal role in fostering this environment by promoting social presence, facilitating cognitive presence, and actively participating in teaching presence.

Moreover, the sense of community cultivated through social construction and communities of inquiry provides emotional support, motivation, and a shared responsibility for learning. Students feel connected to their peers and instructors, which contributes to a positive learning experience. The collaborative nature of these environments also encourages students to take ownership of their learning and become more self-regulated learners, further enhancing their course performance.

Online Student Engagement

Online student engagement (OSE) is an important indicator of online learning and a predictor of grades and course completion (Lin, Hung, & Chen, 2019; Soffer & Cohen, 2019; Tsai, Ku, & Campbell, 2021; Young, 2006; Zimmer, 2023). OSE is typically defined as the amount of time and energy students put forth toward course activities (Dixson, 2010; Swan et al., 2000; Young, 2006). Social construction and CoI theories both support that the notion that students need to engage with the course in its totality. This means engagement with the course content, the professor, and the other students in the course (Dixson, 2010, 2015). Prior studies have shown the positive impact of interactions with professors, dynamic course discussions, and an easy-to-use course

interface on course performance (Swan et al., 2000). Other studies have shown that positive interactions between students and professors enhance course learning and enhances student engagement by fostering a nonthreatening and supportive learning environment (Skinner & Pitzer, 2012; Tsai et al., 2021). From this, it can be concluded that course activities that allow for increased interaction with the material, the professor, and other students are critical in forming a supporting and engaging learning experience.

Substantial research has gone into understanding what creates online student engagement with a brief summary of the studies and their findings shown in Table 1. However, where research has been relatively quiet is on what impedes the formation of OSE, and that is the focus of this study. All the best design practices and engagement techniques are for naught if the students will not use them or work to minimize their use of them due to other factors, and anxiety can quickly destroy or prevent students from engaging with course material.

Table 1. Review of past studies investigating OSE and their main findings.

Study	**Finding**
Schroeder-Moreno (2010)	students are more engaged in learning when their instructors provide diverse opportunities to interact, communicate, and discuss materials online.
Khan, Egbue, Palkie, and Madden (2017)	Online debates are ways for students to display their knowledge and interact with each other.
Dabbagh and Kitsantas (2012)	Online tasks that encourage peer-to-peer feedback and knowledge creation are found positively related to students' engagement
Fisher and Baird (2005)	Collaborative group projects, group reflection exercises, resource sharing, and knowledge creation tasks have a positive impact on student engagement
Bolliger and Halupa (2018)	Student engagement is predicted by transactional distance which Moore (1991) explains is the perceived distance students feel that instructors need to overcome in their online courses.
Dixson, Greenwell, Rogers-Stacy, Weister, and Lauer (2017)	Immediacy behaviors which are defined as verbal and nonverbal communicative actions that send positive messages of liking and closeness and include things like tone, emoticons, chronemics, and aesthetics like color, fonts, and visual imagery are related to online student engagement.
Martin, Wang, and Sadaf (2018)	Students rated timely responses to questions and feedback on assignments as the most important online facilitation strategy to develop engagement.

The Destructive Role of Anxiety

Bandura (1977), famous for his concept of self-efficacy, developed Social Cognitive Theory (SCT), a theory that was intended to describe the whole of human behavior. Central to SCT is the principle of reciprocal determinism which argues that the person, the behavior, and the environment all interact with one another to determine each other. What keeps reciprocal determinism from devolving into an undecomposable wholism is that time separates the influences of person, environment, and behavior on each other (Bandura, 1983). Since creating an engaging course is critical for a successful outcome (Nevid et al., 2022; Zimmer, 2023), it is important to understand effects that can impede the creation of course engagement, and the relationship between anxiety and performance is well documented, but in an online course, different types of anxiety are especially prevalent among students—generalized computer anxiety and computer-mediated computer anxiety.

Computer anxiety

Computer anxiety is a type of state anxiety an individual experiences by being in the presence of a computer. It is experienced only when in the presence of an anxiety trigger, in this case, a computer. Since computer anxiety is a state anxiety that means it can be addressed and treated (Chu & Spires, 1991; Fakun, 2009). Computer anxiety manifests both physiological and psychological affects such as sweaty palms, dizziness, shortness of breath, and the inability to act on a computer (Beckers, Rikers, & Schmidt, 2006; Hemby, 1998; Rinck et al., 2010). Previous works have shown a negative impact of computer anxiety on general attitudes towards computers (Venkatesh, 2000), intentions to use computers (Vallade, Kaufmann, Frisby, & Martin, 2021), and actual performance when using a computer (Brosnan, 1998; Desai, 2001). In terms of SCT, computer anxiety would be considered a cognitive construct that impacts an individual's specific behavior, and given importance of computers to an online course, it is useful to further investigate the relationship between computer anxiety and online engagement.

Computer-Mediated Computer Anxiety

Computer-mediated communication anxiety (CMCA) refers to the discomfort, unease, or fear experienced by individuals when engaging in online communication platforms (Brown, Fuller, & Vician, 2004; Wombacher, Harris, Buckner, Frisby, & Limperos, 2017). Unlike face-to-face interactions, CMC lacks the cues and nuances present in traditional communication, such as facial expressions, body language, and tone of voice. This absence of non-verbal cues can make individuals feel uncertain, self-conscious, or anxious, leading to communication difficulties and a sense of disconnectedness. CMCA differs from computer anxiety as CMCA refers to the discomfort individuals may experience when engaging in online communication. It is specifically related to the challenges associated with communicating through digital means. Computer anxiety, on the other hand, is a broader term that encompasses a range of anxieties associated with using computers. Computer anxiety can manifest as fear of technology, fear of making mistakes, fear of damaging the computer or software, or feeling overwhelmed or incompetent when using digital tools. While computer-mediated communication anxiety is specifically related to the challenges of online communication, computer anxiety is a broader fear or unease related to technology use in general.

Since the only type of communications that occur in an online class is computer mediated, understanding how feelings of CMCA impact engagement is important. Just as Thatcher and Perrewe (2002) found that individuals with computer anxiety were unable to complete computerized tasks effectively, individuals with CMCA likely experience a similar mindset, and CMCA negatively impacts their experience in online courses and masks their true level of course mastery (Saade & Kira, 2009). Those with CMCA may participate in fewer student-student and student-content interactions thereby leading to lower levels of learning (Kuo, Walker, Belland, & Schroder, 2013). Similarly, other works have demonstrated a negative relationship between CMCA and participation in online forums (Sherblom, Withers, & Leonard, 2013; Wombacher et al., 2017). Since online discussions are a primary tool for building engagement, it is expected that those with greater levels of CMCA will be less engaged with the course.

Course Modality

Despite online courses being very popular prior to the pandemic, the majority of students still took traditional face-to-face (F2F) courses. During the height of the pandemic, there was no choice as 100% of all courses were online and this provided a unique opportunity to investigate computer anxiety and CMCA as students could alleviate much of their anxiety by simply enrolling in F2F courses thereby aligning their desire to avoid feelings of anxiety with their overall educational goals. The only option during the pandemic was online courses so students who prefer F2F courses either had to drop out and return once in person learning resumed or they had to take online courses.

Within the online course space an important distinction between synchronous and asynchronous learning has to be made. Synchronous learning occurs in real-time, where students and instructors engage simultaneously, typically through video conferencing or live chat platforms. Synchronous learning facilitates immediate interaction, collaboration, and discussion, simulating the benefits of face-to-face instruction. Asynchronous learning, on the other hand, allows students to access course materials and complete assignments at their own pace, without real-time interaction. Asynchronous learning provides flexibility, accommodating various schedules and time zones, and allowing students to review materials as needed. It fosters independent learning but may require self-motivation and organization skills. It is expected that when a student's preference for course modality is aligned, that student will be more engaged in the course e.g., a student who prefers F2F courses will be more engaged in a F2F course. This leads to the following hypothesis:

H1: There will be a difference in OSE based on a student's course modality preference.

Considering all the content in this section, this study would argue that in the presence of computer anxiety, CMCA, or a mismatch in a student's preferred course modality, engagement will be negatively impacted. However, differing levels of these constructs could exacerbate or diminish the effects of the others. For example, a student who prefers online courses who is comfortable communicating via computer but is anxious about computers in general would have a different level of engagement than another student who prefers online courses but is very anxious about using a computer as a

communication tool, but has no anxiety about computing in general. In other words it is the interaction of CMCA, computer anxiety, and course modality that drives OSE. This suggests the following hypothesis:

H2: There will be a three-way interaction among CMCA, computer anxiety, and course modality.

Methods

This section details the study participants and the survey items and procedures used to collect the data. All data were collected during the COVID-19 pandemic when all courses were only offered online. The course selected was an introductory MIS course in the college of business core and is a requirement for graduation of all business majors.

Participants

Participants (N = 273) were invited to participate in the study during the two semesters when all university courses were mandated to be fully online. No face-to-face courses were being offered during the data collection window. Of those invited, 266 elected to participate (97.4% participation rate) and usable responses were gathered from 245 participants.

Demographically, 236 participants provided their age. The vast majority (N = 179) were of traditional college age (i.e., 18 – 22 years old) though 57 participants could be considered nontraditional with the oldest participant being 60 years old. For the 236 participants who provided data, the average age was 24.40 years (S.D. = 5.35 years). In terms of class standing, all participants were undergraduate students with 7 being underclassmen (< 60 hours), 116 being juniors (60-90 hours), 113 being seniors (91-120 hours), and 15 having more than 120 hours. Most students had previously taken online courses prior to the pandemic (N = 202) though 50 students reported that their first online experience happened when the university pivoted to mandated online learning in March 2020. When asked to express a preference for course delivery format, 64 preferred F2F classes, 11 preferred synchronous online courses, 32 preferred asynchronous online courses, and 145 had no preference.

Measures

Participants all followed the same format when completing the survey. After being appraised of their rights as participants and consenting to participate, they answered several demographic questions. Once the demographic questions were answered, participants completed multiitem inventories to measure computer anxiety, CMCA, and OSE.

To measure computer anxiety, five items were used from the short computer anxiety scale (Lester, Yang, & James, 2005). Scale reliability was assessed using three methods. First Cronbach's α was calculated and the average variance extracted (AVE) was calculated, A Cronbach above 0.80 is considered good (Nunnally, 1978), and an AVE greater than 0.50 is considered acceptable for research (Hair, Black, Babin, & Anderson, 2010) The Cronbach α for the computer anxiety scale was 0.851 and the AVE was 0.59 both indicating good scale reliability. The items were subsequently

summed to form a single indicator to use for hypothesis testing, and the items are shown in Appendix A. Table 2 contains the correlations and descriptives for this scale.

Table 2. Descriptives and correlations for the computer anxiety scale.

	mean	S.D.	companx1	companx2	companx3	companx4
companx1	5.34	1.55	--			
companx2	11.52	1.85	0.42	--		
companx3	11.23	2.02	0.42	0.58	--	
companx4	11.96	1.83	0.57	0.61	0.70	--
companx5	4.90	1.70	0.46	0.46	0.49	0.61

To measure CMCA, Ten items from the computer-mediated communication apprehension scale were used (Scott & Timmerman, 2005). Cronbach's α and AVE were used to assess reliability of this scale, and both measures indicated that the scale was reliable (Cronback α = 0.792 and AVE = 0.54). The items were subsequently summed to form a single indicator to use for hypothesis testing, and the items are shown in Appendix A. Table 3 contains the correlations and descriptives for this scale.

Table 3. Descriptives and correlations for the CMCA scale.

	Mean	S.D.	1	2	3	4	5	6	7	8	9
CMCA1	17.92	1.69	--								
CMCA2	3.51	1.69	0.06	--							
CMCA3	3.52	1.65	0.28	0.53	--						
CMCA4	18.06	1.47	0.37	0.25	0.28	--					
CMCA5	4.09	1.45	0.07	0.04	0.33	-0.01	--				
CMCA6	3.77	1.78	0.15	0.44	0.28	0.26	0.08	--			
CMCA7	18.75	1.82	0.33	0.19	0.17	0.35	-0.06	0.21	--		
CMCA8	18.78	1.64	0.44	0.20	0.17	0.34	-0.12	0.38	0.64	--	
CMCA9	3.89	1.80	0.13	0.44	0.30	0.24	0.06	0.57	0.27	0.44	--
CMCA10	18.63	1.63	0.45	0.13	0.20	0.37	-0.06	0.34	0.44	0.65	0.36

To measure OSE, 11 items from the online student engagement scale were used (Dixson, 2015). The scale demonstrated good reliability across multiple measures. Cronbach's α was 0.866 and the average variance extracted was 0.53. The items were subsequently summed to form a single indicator to use for hypothesis testing, and the items are shown in Appendix A. Table 4 shows the descriptive statistics and correlations for these items.

Table 4. Descriptive statistics and correlations for the OSE scale.												
	Mean	S.D.	OSE1	OSE2	OSE3	OSE4	OSE5	OSE6	OSE7	OSE8	OSE9	OSE10
OSE1	3.68	1.37	--									
OSE2	4.86	1.16	0.54	--								
OSE3	3.64	1.31	0.62	0.42	--							
OSE4	3.61	1.27	0.66	0.45	0.62	--						
OSE5	3.87	1.47	0.57	0.43	0.44	0.55	--					
OSE6	3.90	1.33	0.48	0.41	0.54	0.61	0.54	--				
OSE7	3.68	1.54	0.33	0.24	0.33	0.39	0.34	0.41	--			
OSE8	4.07	1.47	0.29	0.34	0.29	0.36	0.26	0.40	0.71	--		
OSE9	3.93	1.51	0.22	0.30	0.24	0.25	0.33	0.26	0.38	0.41	--	
OSE10	5.04	1.06	0.33	0.57	0.31	0.35	0.33	0.35	0.28	0.37	0.32	--
OSE11	3.08	1.51	0.24	0.25	0.26	0.23	0.20	0.26	0.28	0.24	0.50	0.24

Results

Before formally testing the study hypothesis, the data was mean centered. Mean centering does not change the regression parameters, but it does make the results of the analysis easier to interpret (Dalal & Zickar, 2012; Kromrey & Foster-Johnson, 1998). The descriptive statistics and correlations are shown in Table 5.

Table 5. Descriptives and correlations for study variables.						
	N	Mean	S.D.	Comp Anx	CMCA	OSE
Computer Anxiety	249	0	7.40	--		
Computer Mediated Communication Anxiety	245	0	7.98	0.16	--	
Online Student Engagement	247	35.95	8.46	-0.18	-0.16	--

Hypothesis 1 Results

Hypothesis 1 states that there will be a difference in the mean level of OSE based on a student's preference for course delivery. In particular, the level of engagement is expected to be higher for students who prefer asynchronous online courses than the other types of course delivery since the course surveyed was an asynchronous online course. However, this hypothesis was not supported ($F_{(3, 243)} = 0.71$, MSE = 71.85, $p = 0.55$, $\eta^2 = 0.01$), meaning there is no difference in OSE based on course delivery mode. The implications of this finding will be developed in the discussion section.

Hypothesis 2 Results

To test the study hypothesis, an ANOVA was conducted to test the three-way interaction of course modality preference, computer anxiety, and computer mediated communication anxiety. The results of this test were significant ($F_{(15, 229)} = 3.07$, MSE = 63.21, $p < 0.0001$, $\eta^2 = 0.17$). Since the omnibus test was significant, it is appropriate to investigate the individual terms entered into the model. When testing the three-way interaction, it was significant ($F_{(3, 229)} = 2.73$, MSE = 63.21, $p = 0.04$, $\eta^2 = 0.03$). This indicates that the interaction between computer anxiety and computer mediated

communication anxiety differs among course modality preferences. The subsequent sections provide these analyses.

Students with no preference in course delivery

The majority of students (N = 142) expressed no preference for course modality. This was not surprising because only 32 students reported that their first online course was when they were forced to go online because of the COVID-19 pandemic. Another 220 students reported their first online course was prior to the pandemic. When testing the effects of computer anxiety and computer-mediated communication anxiety, the omnibus test indicated that there is a significant impact on OSE ($F_{(3, 138)} = 4.41$, MSE = 59.81. $p = 0.0054$, $\eta^2 = 0.09$). However, the specific test for the interaction of computer anxiety and computer-mediated communication anxiety was not significant, and the main effect test for computer anxiety was also not significant. Only computer-mediated communication anxiety was significant. This test indicates that engagement decreases and CMCA increases meaning more anxious students are less engaged. This finding is in line with previous research (Vallade et al., 2021; Wombacher et al., 2017). The results of these tests are contained in Table 6.

Table 6. Results for students with no preference in course delivery.

	β	S.E. β	$F_{(1, 138)}$	p	η^2
Computer mediated communication anxiety	-0.34	0.68	12.08	0.0007	0.08
Computer anxiety	0.01	0.10	0.02	0.88	0.0001
Interaction effect	-0.007	0.01	0.42	0.52	0.003

Students who prefer F2F courses

The second largest group of students (N = 64) expressed a preference for face-to-face classes. When testing the effects of computer anxiety and computer-mediated communication anxiety, the omnibus test indicated that there is a significant impact on OSE ($F_{(3, 56)} = 4.15$, MSE = 68.04, $p = 0.01$, $\eta^2 = 0.18$). The specific test for the interaction of computer anxiety and computer-mediated communication anxiety was also significant, but the main effect test for computer anxiety and computer-mediated communication anxiety were not significant. These results are shown in Table 7.

In the presence of an interaction, the main effects are not interpreted as the relationship depends on the interaction. Analyzing the simple slopes shows the nature of the relationship between computer anxiety and computer-mediated communication anxiety with OSE.

Table 7. Results for students who prefer F2F courses.

	β	S.E. β	$F_{(1, 56)}$	p	η^2
Computer mediated communication anxiety	-0.05	0.12	0.18	0.67	0.002
Computer anxiety	0.08	0.17	0.23	0.64	0.003
Interaction effect	-0.02	0.01	5.72	0.02	0.084

To gain an understanding of how the interaction between CMCA and computer anxiety impacts OSE, the predicted values for OSE were calculated from the regression equation and plotted. This yields a three-dimensional surface where CMCA and computer anxiety form the X and Y axis and the predicted values for OSE form the Z axis. Using the ranges for CMCA and computer anxiety for students who prefer F2F courses to define the absolute limits of the response surface yields the shape shown in Figure 1.

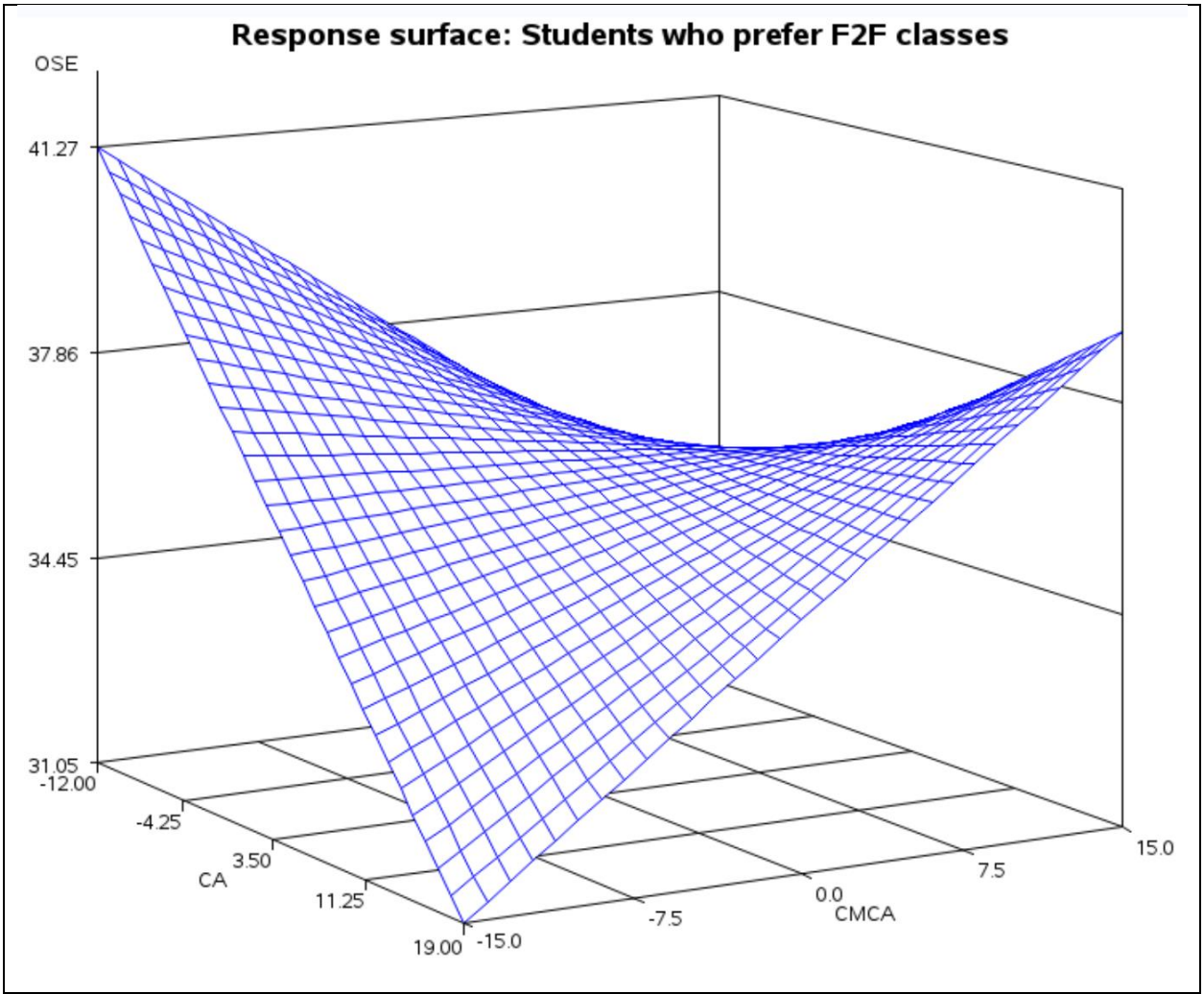

Figure 1. Response surface for predicted OSE values for students who prefer F2F classes.

Looking at the surface, the interaction is a saddle shape which means that looking at the relationship between CMCA and OSE changes based on the level of computer anxiety a student has. Since understanding the exact nature of the relationship of the interaction is overwhelming when viewed as a response surface, the simple slopes are calculated and presented in the following section.

Rather than trying to use the response surface in Figure 1 to interpret the interaction, it is easier to take cross sections of that surface in three places to look at the relationship between the variables of interest. Popular convention uses one standard deviation

above and below the mean as well as the mean as the values for those slices. These three slices provide high, medium, and low values of one independent variable with which to view the relationship between the other independent variable and the dependent variable. The subsequent analyses will take low, average, and high levels of CMCA and see how the relationship between computer anxiety and OSE changes based on the level of CMCA a student has.

One would expect that the more anxiety an individual experiences, whether that anxiety is CMCA or computer anxiety, the less engagement that student would have with the course. However, because the shape of the interaction is saddle shaped, this is not the case. When students have low and average levels of CMCA, the relationship between computer anxiety and OSE is, indeed, negative. This means that not experiencing anxiety over using the computer as a communication tool does not offset or alleviate the general computer anxiety a student has in terms of engaging with course material. However, those students who are anxious about using a computer as a communication tool see their engagement increase with additional levels of computer anxiety. A possible explanation for this finding will be explored in the discussion section. A plotting of the simple slopes showing the relationship between computer anxiety and OSE for low, average, and high levels of CMCA is shown in Figure 2.

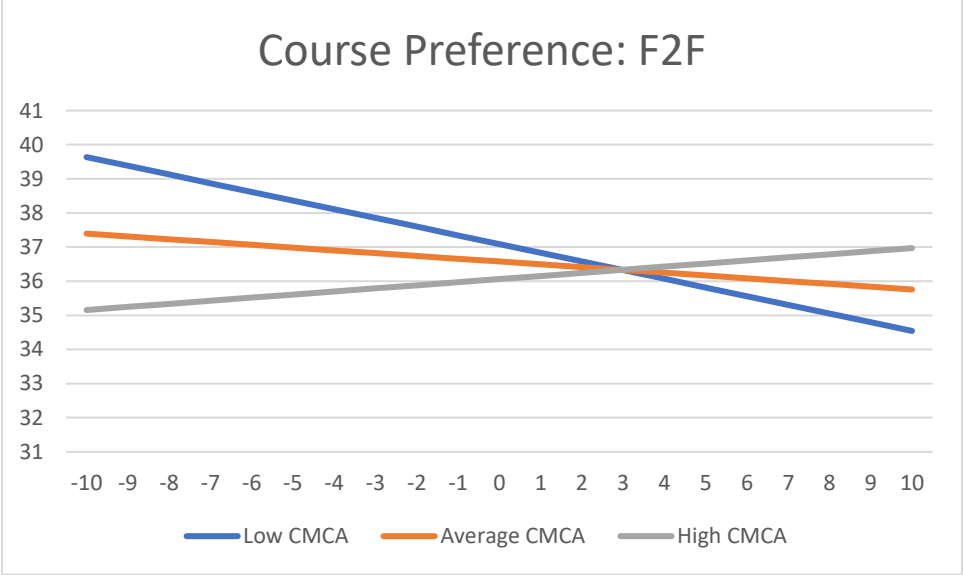

Figure 2. Simple slopes analysis for students who prefer F2F courses.

Students who prefer synchronous online courses

Not many students (N = 11) said that they preferred synchronous online courses. When testing the effects of computer anxiety and computer-mediated communication anxiety, the omnibus test indicated that there is not a significant impact on OSE ($F_{(3, 7)} = 2.11$, MSE = 75.12, p = 0.18, $\eta^2 = 0.47$). With a sample this small, these results could be due to a lack of power. Since the omnibus test was not significant, the results for each variable are not reported.

Students who prefer asynchronous online courses

The smallest meaningful group of students (N = 32) reported a preference for asynchronous online courses. When testing the effects of computer anxiety and computer-mediated communication anxiety, the omnibus test indicated that there is a significant impact on OSE ($F_{(3, 28)} = 3.22$, MSE = 67.34, $p = 0.03$, $\eta^2 = 0.26$). The specific test for the interaction of computer anxiety and computer-mediated communication anxiety was also significant, as was the main effect for CMCA, but the main effect test for computer anxiety was not significant. These results are shown in Table 8.

Table 8. Results for students who prefer asynchronous online courses.

	β	S.E. β	$F_{(1, 28)}$	p	η^2
Computer mediated communication anxiety	-0.90	0.32	8.02	0.009	0.22
Computer anxiety	-0.09	0.26	0.11	0.74	0.003
Interaction effect	-0.09	0.04	5.08	0.03	0.14

In the presence of an interaction, the main effects are not interpreted as the relationship depends on the interaction. Analyzing the simple slopes shows the nature of the relationship between computer anxiety and computer-mediated communication anxiety with OSE.

To gain an understanding of how the interaction between CMCA and computer anxiety impacts OSE, the predicted values for OSE were calculated from the regression equation and plotted. This yields a three-dimensional surface where CMCA and computer anxiety form the X and Y axis and the predicted values for OSE form the Z axis. Using the ranges for CMCA and computer anxiety for students who prefer asynchronous online courses to define the absolute limits of the response surface yields the shape shown in Figure 3.

Looking at the surface, the interaction is another saddle shape which means that looking at the relationship between CMCA and OSE changes based on the level of computer anxiety a student has. Since understanding the exact nature of the relationship of the interaction is overwhelming when viewed as a response surface, the simple slopes are calculated and presented in the following section.

Much like when the interaction between CMCA and computer anxiety was significant for students who prefer F2F courses, the interaction between CMCA and computer anxiety was significant for students who prefer asynchronous online courses as well. The simple slopes for this set of students were also calculated. Similar to the analyses conducted in Section 4.2.2, the predicted relationship between computer and OSE was calculated for low, average, and high levels of CMCA. Despite the saddle shaped response surface, the simple slopes show a more expected pattern (see Figure 4).

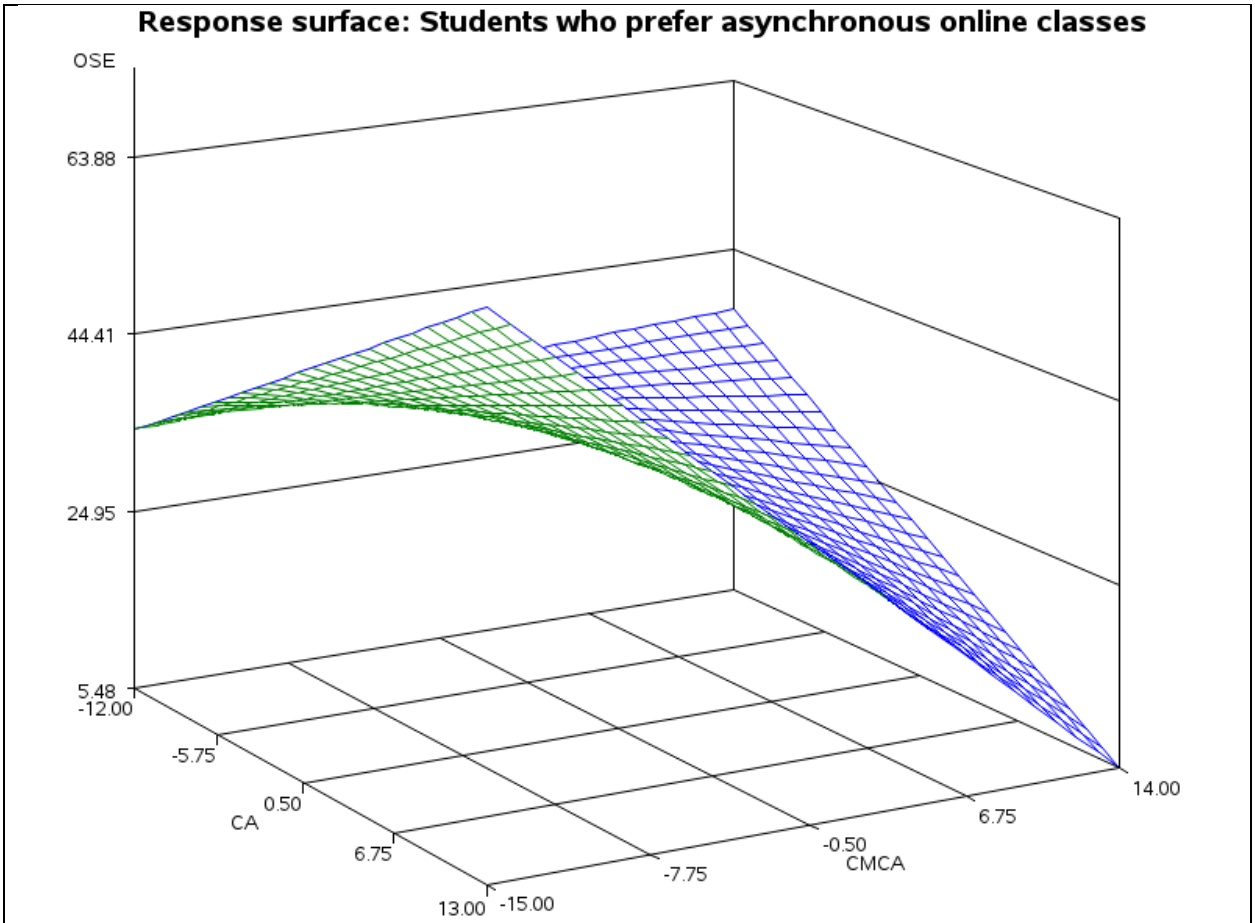

Figure 3. Response surface for predicted OSE values for students who prefer asynchronous online classes.

When students have lower levels of computer anxiety, there is no real difference in the level of engagement based on CMCA, but differences appear as computer anxiety increases. When students have high levels of CMCA, engagement diminishes as computer anxiety increases, however the opposite pattern is seen when students have low levels of CMCA, and engagement actually increases as computer anxiety increases. An explanation for this finding will be offered in the discussion section.

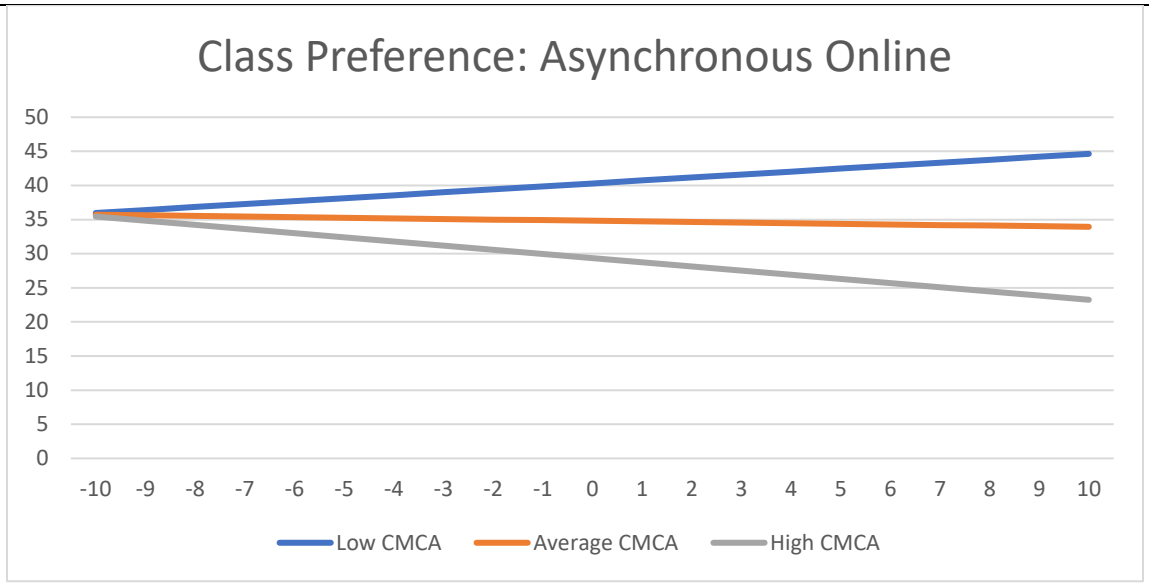

Figure 4. Simple slopes analysis for students who prefer asynchronous online courses.

Discussion

Prior studies have shown that online student engagement is an important driver of course success (Lin et al., 2019; Soffer & Cohen, 2019; Tsai et al., 2021; Young, 2006; Zimmer, 2023). However, previously lacking in the literature was evidence of factors that could impede the formation of student engagement. This study takes a first step toward understanding what impedes online engagement. The following sections develop and discuss the findings of the previous analyses.

Course Modality and OSE

It was expected that students who preferred to take asynchronous online courses would demonstrate higher levels of OSE than students who preferred a different way of taking a course since the characteristics of the learning environment did not align with the student's preferences for course modality. It was expected that this mismatch would impact a student's level of engagement in the course thereby leading to decreased motivation, disinterest, and ultimately lower performance. However, this was not the case, and no mean differences in OSE were observed between students of different course modality preferences.

A possible explanation for this finding is that technology and instructional methods offset the impact that course modality would otherwise have. The course used in this study had students writing SQL queries and using a data visualization tool and made extensive use of required discussion boards. Perhaps in a more traditional lecture-oriented course, differences in engagement based on modality preferences might have been observed. Future research should investigate the effects of course modality, instructional methods, and technology platform on student engagement.

The Effects of CMCA, Computer Anxiety, and Modality on OSE

Hypothesis 2 argued for a three-way interaction of CMCA, computer anxiety, and course modality, and this hypothesis was supported. The data was subsequently analyzed across modality preferences looking at the interaction of CMCA and computer anxiety on OSE, and only students who prefer F2F classes and asynchronous online courses had a significant interaction though the nature of the interaction differed among course modalities.

For students who prefer F2F courses, those with low and average levels of CMCA saw a negative relationship between computer anxiety and OSE meaning for those two types of students, computer anxiety diminished OSE. However, the students with high levels of CMCA saw their levels of engagement increase as computer anxiety increases meaning those students with the highest levels of both CMCA and computer anxiety were actually more engaged than students with lower levels of anxiety. This finding is surprising and could be the result of those most anxious calling on other psychological reserves to persevere through their anxiety and work to engage with course content in order to do well. Future research should work to understand this finding. Do these students have other coping skills or high amounts self-control they can use to overcome feelings of anxiety. Lower levels of anxiety have been known to lead to a lack of motivation or a sense of complacency (Keeley, Zayac, & Correia, 2008). The course surveyed is required for graduation, so perhaps different results would be observed in an elective course.

For students who prefer asynchronous online courses a different view of the interaction between CMCA and computer anxiety was observed. There was relatively little difference in the amount of engagement between the CMCA groups when computer anxiety was low, but as computer anxiety increased, differences in OSE became apparent based on a student's CMCA. Those students with low levels of CMCA saw their predicted OSE scores increase as their computer anxiety increased while those with high levels of CMCA saw the opposite—their predicted OSE decreased. Those with average levels of CMCA saw no differences in OSE as computer anxiety increased.

A possible explanation for this is those students with low levels of CMCA are able to use the computer as a communication tool and overcome their anxiety about using a computer in general to engage with the course material. However, those who are anxious about using a computer as a communication tool, fall into a negative feedback loop and withdraw and are even less engaged as the two different types of anxiety have a compounding effect on engagement. Finally, those with average levels of CMCA are able enough to overcome their anxiety to at least not have a detrimental effect on OSE as their computer anxiety increases.

From a practical perspective, it is impossible to design a course perfectly suited for each modality preference. However, the professor can use different techniques to try to increase engagement based on how a student prefers to experience a course. The biggest impact would be to take steps to alleviate CMCA in those students who express no preference for any modality or asynchronous modality. Those with no preference for modality saw a negative relationship between CMCA and OSE, so addressing that should increase OSE and by extension, course performance. For those who prefer asynchronous online courses, alleviating CMCA should enable the students to overcome any computer anxiety they may have and thereby become more engaged

with the course. As for how to alleviate CMCA, no studies investigating the precursors to CMCA could be located, but creative a supportive online environment, providing clear examples and strong rubrics for discussion expectations, offering technical support, providing detailed student feedback on assignments, offering alternative communication channels, and the professor clearly communicating their availability and approachability are all ideas that stand to reason though future research should investigate these ideas and how they impact CMCA. Additionally, prior works have shown the efficacy of providing clear examples and strong rubrics and providing detailed student feedback on assignments have helped alleviate other forms of anxiety students often feel (Ciftci, Karadağ, & Akdal, 2014)

As for those who prefer F2F courses, both CMCA and computer anxiety should be addressed to increase online engagement. These students would prefer to be in a F2F environment and could be anxious about using the technology, and they could be anxious about having to use the computer as a communication device. Looking at the response surface in Figure 1, the highest levels of OSE are observed at the lowest levels of both CMCA and computer anxiety. In addition to the possible suggestions above on how to address CMCA, prior works have shown the following techniques to be effective at reducing computer anxiety. First minimizing the use to technical jargon when talking about technology (Scull, 1999). Second, helping students to accurately assess the tasks they will be required to demonstrate or do on the computer (Chang, 2005), third and incorporating coping messages into the activities being performed can all help alleviate the negative effects of computer anxiety (Huang & Mayer, 2016).

Study Limitations and Avenues for Future Research

No study is perfect, and this one is no exception though the strength of this study does outweigh its shortcomings. First, society is moving into a post COVID-19 world and universities have resumed F2F courses. The COVID-19 pandemic was unlike anything since the influenza pandemic of 1918 and as such, something of a similar magnitude is not likely to occur in the near future. However, online offerings are as popular as ever and many workplaces are struggling with a distributed workforce and trying to balance in person versus virtual work. It is expected that the same relationships demonstrated in this study would also be relevant to working professionals. Hence understanding how individuals prefer to work and the interaction of computer anxiety and CMCA will be of continued importance even in a post-pandemic world.

Another possible shortcoming is only one course was selected and these relationships may differ based on the course being offered. The course used for data collection was an introductory MIS course in a college of business. It is required of all business majors and minors, and so it is taken by a wide array of different students with different academic backgrounds. Being an introductory MIS course, the course was not only an online course, thereby possibly exacerbating feelings of computer anxiety, but it also features heavy use of two different software packages—a database management system and data visualization software, neither of which students have used before. This course would definitely exacerbate computer anxiety in students as opposed to a more traditional lecture-based PowerPoint driven course. Unlike other required computing courses like business statistics that feature Excel, where students have different backgrounds and experiences with the software, this course puts all students

on equal footing in terms of software use and thus provides a better picture of the interplay of computer anxiety, CMCA, and course modality preference. However, it could be interesting to see how the relationships observed here hold up if different courses like an introductory programming or math courses were to be used. Future research should replicate this study using a broader array of courses.

Finally, future research should continue to investigate CMCA. As a construct, research into CMCA is just beginning and therefore filling out its nomological network is important. While similar to the more general computer anxiety, CMCA did demonstrate a different relationship to OSE in the data, and the causes of and mitigations for CMCA are likely to be different than addressing and mitigating computer anxiety. Only future research can address this shortcoming in the literature.

Conclusion

This paper has explored the intricate relationship between computer anxiety, CMCA, and course modality, shedding light on how these factors interact to influence OSE. Computer anxiety, stemming from fear or discomfort with technology, can impede students' willingness to engage in online learning environments. The unfamiliarity with computers and associated tools may hinder their ability to navigate digital platforms and perform essential tasks, thereby limiting their overall engagement. Furthermore, CMCA adds another layer of complexity to the equation. Communicating through digital channels can be daunting for students, as they may feel apprehensive about expressing themselves effectively or interpreting messages accurately. This anxiety can manifest as reduced participation in online discussions, reluctance to seek clarification, or an overall hesitancy to engage in collaborative activities. Though no difference in OSE was observed strictly due to course modality preference, a well-designed course that promotes clear communication channels, offers comprehensive technical support, and fosters a sense of community can alleviate anxiety and facilitate increased student engagement.

Understanding the interplay between these factors is crucial for educators and institutions aiming to enhance online student engagement and by extension, course performance. By addressing computer anxiety, professors can empower students to overcome technological barriers. Similarly, implementing strategies to alleviate CMCA can encourage active participation and meaningful interactions. Ultimately, the successful engagement of online students relies on a holistic approach that takes into account the complex interconnections between computer anxiety, CMCA, and course modality. By cultivating a supportive and inclusive online learning environment, educators can help students overcome anxieties, maximize their engagement, and foster a positive and enriching educational experience.

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Appendix A: Study Survey Items

Computer Anxiety (Lester et al., 2005)

Anchors: Strongly agree—Strongly disagree

1. I feel confident and relaxed while working on a computer.
2. The harder I work at learning computers, the more confused I get.
3. I sometimes feel that computers do not like me.
4. I have always had problems working on computers.
5. I can usually manage to solve computer problems by myself.

CMCA (Scott & Timmerman, 2005)

Anchors: Strongly agree—Strongly disagree

1. I look forward to the opportunity to interact with others on the computer.
2. Although I speak fluently with friends, I am at a loss for words when interacting online.
3. I always avoid communication via computer if possible.
4. I feel that I am more skilled than most others when interacting with people online.
5. I dislike having to limit my communication to whatever is possible on a computer.
6. I am afraid to voice my opinions when interacting with others on the computer.
7. I would enjoy giving a presentation to others online.
8. I look forward to expressing myself during online meetings.
9. I am afraid to express myself in group discussions online.
10. I like to get involved in computer-based group discussions.

OSE (Dixson, 2015)

Anchors: Not at all characteristic of me—Very characteristic of me

Please indicate how well the following behaviors, thoughts, and feelings describe you and your experiences in this course…

1. Making sure to study on a regular basis.
2. Putting forth my best effort.
3. Staying current on the text readings
4. Looking over class notes between getting online to make sure I understand the material.
5. Taking good notes over readings, PowerPoints, or video lectures.
6. Listening/reading the text carefully.
7. Applying course material to my life.
8. Finding ways to make the course interesting to me.
9. Helping fellow students.
10. Getting a good grade.
11. Getting to know other students in the class.