The Impact of Multimodal Communication on Learners' Experience in a Synchronous Online Environment: A Mixed-Methods Study

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Abstract
During the COVID-19 pandemic, from early 2020 onwards, the adoption of synchronous online learning increased rapidly. It offers students a unique learning experience, utilizing communication modes from both in-person and asynchronous online classes. This mixed-methods study examined the impact of modes of communication (visual, bodily behaviors, spoken language, and written language) found in synchronous online contexts on students' learning experiences from the perspective of social presence and teaching presence, as well as their satisfaction with synchronous online learning experience. An online survey was distributed first to collect quantitative data. The survey results indicated that four different modes influenced students' communication to a different extent, with written and spoken language being the most effective modes of online communication. These modes were also significantly positively correlated with social presence, teaching presence, and student satisfaction; however, only spoken language was a significant predictor of student satisfaction. In the qualitative phase, semi-structured interviews were conducted to examine students' perceptions of how multimodality affects social presence, teaching presence, and satisfaction with online learning. This led to five major themes and highlighted how multiple modes of communication supports social presence, thereby helping teachers scaffold students. In addition, the online learning context impacts type of instruction, and the reduced distance between teachers and students improves teaching presence; however, the students felt a lack of affective belonging in their online classes. This study also provided implications for course instructors and designers to help them effectively adopt different modes in synchronous online environments and promote social and teaching presence.
Keywords: Multimodality, synchronous online learning, social presence, teaching presence

Online learning grew tremendously during the COVID-19 pandemic, especially throughout 2020, as educational institutions were required to offer online courses (Hodges et al., 2020). Educators increasingly turned to video conferencing technology to teach classes (Henriksen et al., 2020). Thus, synchronous online teaching gained traction, becoming widely adopted (Cheung, 2021). In the context of synchronous online learning, students have access to various communication tools such as in-time communication via microphone, which are often less used in asynchronous online environments. (Hoffman, 2018). The technology and tools in synchronous online environments have provided students with more semiotic resources. In social semiotics, meaning is created not only by language but also by gestures, actions, clothing, social context, and symbols that have significance in a community (Hawkes & Hawkes, 1977; Silverman, 1983). Multimodality refers to a set of semiotic resources that use various modes of communication such as images, gestures, gazes, postures, and digital sources (Jewitt, 2011; Toohey et al., 2015) or an integration of them all (Erfanian et al., 2019). For example, in synchronous online contexts, students can communicate in real time by employing various modalities offered by semiotic resources facilitated by technology, such as chat boxes and microphones (Hoffman, 2018). Also, synchronous, video-based platforms provide instructors and students with the most realistic in-person communication experiences (Lowenthal et al., 2021; Romero-Hall & Vicentini, 2017). The synchronous video-based platforms allow students to communicate orally in real time, exchange messages by typing, and receive timely responses (McBrien et al., 2009). In addition, the webcam enables students to communicate via an array of modes, including postural shifts, gestures, and head movements. Thus, the different modes of communication enhance communication, creating an enriched learning experience for students relative to the asynchronous online learning environments.

This study aimed to examine how multimodal communication impacts students' experiences in synchronous online learning. According to Garrison (2009), the community of inquiry (CoI) framework focuses on the elements of the educational experience. The essential components of this process are social, teaching, and cognitive presences. Since cognitive presence addresses students' development of critical and higher-order thinking (Garrison et al., 2001), the current study only examined the ways in which multimodal communication impacts students' experience in terms of social and teaching presences. In addition, the previous literature has suggested that augmenting communication and interaction between students and instructors provides harmonious learning experience (Kuo et al., 2014). However, the different modes of communication applied within synchronous online learning were not explored sufficiently (Erfanian et al., 2019; Hoffman, 2018), and thus, their impact on students' learning experiences was not thoroughly investigated. Hence, this study aimed to establish how the four modes of communication (i.e., visual elements, written language, spoken language, and bodily behavior) affect students' experiences in synchronous online learning courses.

Review of Literature

Multimodal Theory of Communication

Social semiotics is the study of the social dimensions of meaning and how the processes of signification and interpretation shape individuals and societies (Leeuwen, 2005). That is, social semiotics focus on how social meaning is created in all kinds of forms, such as visual and verbal (Kress & Leeuwen, 2001). In the context of teaching and learning, learning is a process of engagement with a variety of modes (Bezemer & Kress, 2016). The multimodal theory of

communication investigates how people employ multimodal communication during interactions (Hoffman, 2018). Forceville (2020) defined nine types of multimodal communication: (a) visuals, (b) written language, (c) spoken language, (d) bodily behavior, (e) sound, (f) music, (g) olfaction, (h) taste, and (i) touch. However, as Hoffman (2018) observed, multimodality is identical in the contexts of synchronous online classes, asynchronous online teaching, and face-to-face teaching, mainly about four aspects: visuals, written language, spoken language, and bodily behavior. Specifically, in a synchronous online learning environment, visual elements include eye contact, images, videos, or the course material design screens shared by the instructors. Written language comprises chats, emoticons, and icons. Spoken language includes speaking via microphone. Bodily behavior encompasses gestures, postures, facial expressions, and movement (Bezemer & Kress, 2016; Hoffman, 2018), and these four modes were examined in this study.

Some scholars in the field of language education adopted the multimodal theory of communication to analyze students' learning via video conferencing. For instance, according to Meskill and Anthony (2010), real-time text chat could potentially enhance teaching as it combines the spoken mode with written language, visuals, and real time communication. This would enable language instructors to capitalize on the multimodal nature of the teaching medium by offering feedback without interfering with the learning process. However, research into how different modes of communication can impact learners' online learning experiences has been limited to other fields.

In the synchronous online learning environment, multiple modes of communication provide learners with diverse opportunities for synchronous communication. According to Garcia and Jacobs (1999), synchronous communication is dialogic communication that proceeds simultaneously in a shared communicative space, whether physical or virtual. That is, video and audio conferencing, and face-to-face communication, are included in this definition. However, in the current study, only synchronous online communication was discussed. In synchronous online learning, students and instructors can communicate in real-time using multiple modes of communication, such as written text in a chat box and spoken language using the audio tools.

Social Presence and Teaching Presence

Community of Inquiry (CoI) has been widely accepted as a framework to explore and understand students' online learning experiences. This framework comprises three elements: social, teaching, and cognitive presence, and corresponding categories and indicators that define each component of presence (Garrison & Arbaugh, 2007). According to Garrison and Arbaugh (2007), cognitive presence is a cycle of practical inquiry involving learners moving deliberately from understanding a problem to exploring, integrating, and applying it. Social presence, according to Garrison (2009), refers to "the ability of participants to identify with the community (e.g., course of study), communicate purposefully in a trusting environment, and develop inter-personal relationships by ways of projecting their individual personalities" (p. 352). Whereas teaching presence is defined as "the design, facilitation and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes" (Garrison et al., 1999, p. 96).

Studies have often focused on one aspect of presence, or a combination of different types of presences in the online learning environment (e.g., Arbaugh & Hwang, 2006; Liaw & Ware, 2018). However, the majority of research adopting the CoI framework has focused on investigating asynchronous online contexts using text-based communication (e.g., Poquet et al.,

2018). For example, social presence has been examined across a number of studies as a way to analyze the use of text-based online discussion forums (Zou et al., 2021). Additionally, Anderson et al. (2001) and Garrison et al. (1999) analyzed teaching presence in asynchronous online environments. They suggested that teaching presence can be created and sustained in text-based communication despite the absence of non-verbal and paralinguistic cues. Nevertheless, asynchronous text-based communication presents unique challenges to the development of effective teacher presence (Garrison et al., 1999). Although researchers have examined asynchronous online environments (Anderson et al., 2001; Garrison et al., 1999), as Lambert and Fisher (2013) noted, limited studies have focused on investigating synchronous online teaching. Thus, research is needed to look beyond the asynchronous environments and explore how different modes of multimodal communication available in the synchronous online environment impact students' learning.

Research has shown that mode of communication can significantly influence the dynamics of how people communicate (Liaw & Ware, 2018). Students in a community of inquiry, whether synchronous or asynchronous, may tend to project themselves socially and emotionally through communication (Garrison et al., 2001), developing varying degrees of social presence. In addition, the multimodalities considered relate to students' perceived teaching presence, since a lack of communication causes students to perceive of instructors as absent and incapable of coordinating sessions, which results in dissatisfaction with learning (Afolabi, 2016).

Cognitive presence is focused on students' development of critical and higher-order thinking (Garrison et al., 2001). Meanwhile learners' communication is fundamental to developing cognitive presence, as other factors also contribute to their critical thinking skills. For example, group composition significantly enhances cognitive presence (Garrison & Arbaugh, 2007), with students' personalities also being an important variable (Lee & Lee, 2006). Additionally, teaching activities and educational context significantly affect the development of cognitive presence (Garrison & Cleveland-Innes, 2005). Therefore, considering the focus of this study is on multimodal communication, we limited the scope of the investigation to social and teaching presences only.

Online learning contexts could enable students to establish a social presence (Swan et al., 2008). Social presence fosters a sense of belonging that supports an environment in which students can openly communicate with their peers to negotiate a variety of perspectives and confirm mutual understandings. According to Garrison et al. (1999), three sub-dimensions constitute social presence: affective expression, open communication, and group cohesion. Open communication requires students to share their emotions, feelings, beliefs, and values with their peers; group cohesion arises when students develop a commitment to the group that they are in. Affective expression refers to using group work to complete tasks in an online course (Garrison & Arbaugh, 2007). Current literature has shown that video conferencing tools provide opportunities for students to interact with their peers and instructors, and thus enhance their experiences of social presence (Hoffman, 2018).

Garrison et al. (2001) concluded that although both social and content-related interactions among learners are vital in online learning environments, these elements alone are insufficient to ensure effective online learning; teaching presence is also needed to direct focus in a specific direction. Teaching presence contains three responsibilities: design and organization, facilitation, and direct instruction (Anderson et al., 2001). According to Garrison and Arbaugh (2007), design and organization concern the curriculum and methods determined by the teacher, facilitating refers to instructors supporting conversations that help learners share their understanding, and

direct teaching focuses on mutual discussion. Several studies have suggested that teaching presence is associated with a wide variety of desirable and valuable student outcomes in online learning environments (Turk et al., 2021). For example, Watson et al. (2016) examined instructors' use of teaching presence and discovered that it determined the quality of student learning experiences. A meta-analysis by Martin et al. (2022) found that teaching presence was strongly correlated with learners' satisfaction in online and blended learning environments.

Student Satisfaction with Online Courses

Student satisfaction can be defined as perceptions of a learning experience and perceived value of the education received (Astin, 1993). In traditional face-to-face learning environments, several factors have been identified as determining student satisfaction with learning, including communication with instructors and students' social experiences with peers (Bolliger & Martindale, 2004). However, the online learning environment has made it more challenging for students to establish relationships with their instructors and fellow students (add citations). Bolliger and Martindale (2004) identified the following factors as contributing to student satisfaction learning online: instructor issues, communication, technology, course management, and interactivity. Other research has shown that student satisfaction with online learning has a strong positive correlation with instructors' performance, particularly availability and response time (DeBourgh, 1999). If there is a lack of communication and interaction with instructors and fellow students, distance learners may experience feelings of isolation and high levels of frustration and anxiety, resulting in dissatisfaction with the learning experience (Mood, 1995). A recent study by Landrum et al. (2021) also supported that student satisfaction with online courses relates to how they interact with faculty and peers. However, having limited or no interaction with peers and instructors resulted in negative perceptions of online learning and lower satisfaction levels with the course (Stewart et al., 2022).

Some researchers have pointed out that augmenting interaction can improve students' perceived satisfaction with learning and that interaction is a key variable influencing student satisfaction in online learning environments (Bray et al., 2008). Additionally, the social interaction and collaboration in both synchronous and asynchronous online learning environments often create a positive learning experience and promote satisfaction (Bolliger & Martindale, 2004). Moreover, Kuo et al. (2014) determined that interactions among learners and among instructors and learners are the most important contributors to student satisfaction in synchronous online courses. With the popularity of synchronous online teaching in higher education and existing literature indicating that synchronous online learning promotes interaction, it is worthwhile to investigate how multimodal communication in this online teaching format impacts learners' satisfaction.

In summary, although some research has investigated multimodality, social presence, and teaching presence in video conferencing in language classes (e.g., Satar, 2015, 2020), few studies have examined the impact of the multiple modes of communication available in the synchronous online context and how they variously affect social presence and teaching presence in other subjects or the broader context of online classes. Therefore, the current study adopted CoI and the multimodal theory of communication as theoretical frameworks, to establish whether four communication modes (visuals, written language, spoken language, and bodily behavior) impact teaching and social presence via communication in synchronous online contexts.

The overarching research question of this study is "How do different modes of communication (i.e., visuals, written language, spoken language, and bodily behavior) impact learners' communication in synchronous online courses and how do they influence learners' social presence, teaching presence, and satisfaction?" The three following aspects will be considered when answering this question:

(1) How is students' communication in the synchronous online environment impacted by different modalities?
(2) What is the relationship between multimodality, social presence, teaching presence, and students' satisfaction in synchronous online classes?
(3) What are students' perceptions of the impacts of different modes (i.e., visuals, written language, spoken language, and bodily behavior) on their perceived social and teaching presences in a synchronous online class?

Methods

A sequential mixed-methods explanatory research approach (Tashakkori & Teddlie, 2003) to both data collection and analysis was implemented to answer the research questions. Quantitative data were first collected and analyzed, followed by qualitative data, since qualitative data helped explain and elaborate on the quantitative results obtained in the first phase.

Data Collection

First, a survey (see Appendix A) was distributed at the end of the fall semester of 2021 to undergraduate students in the School of Liberal Arts in two universities in southwest China. Those students took synchronous online courses during the COVID-19 pandemic in 2020. DingTalk (https://www.dingtalk.com/en) was the online communication platform used by those two universities. Various features available in this platform allowed synchronous communication, including instant chat messages, emoticons and files, and video and audio conferencing.

The online survey consisted of four parts which measured students' social presence, teaching presence, their perceived effectiveness of each of the available modes of communication (i.e., visual, bodily behaviors, spoken language, and written language) in the synchronous online learning environment, and their satisfaction with synchronous online learning. The CoI survey instrument (Arbaugh et al., 2008) was used to measure students' social and teaching presence, and four items were modified to make the survey more appropriate for synchronous online teaching. The adapted version of the questionnaire was piloted among five students and it was decided that no further revisions were needed. Participants were asked to rate items of social and teaching presences and the impacts of modes of communication on a five-point Likert scale, ranging from one (strongly disagree) to five (strongly agree). The Cronbach α for the reliability of the three constructs for this sample in the survey is 0.90 (multimodal), 0.94 (teaching presence), and 0.93 (social presence), respectively. Students were also asked to rate their satisfaction with synchronous online teaching on a ten-point scale and answer two short open-ended questions about the aspects they were most and least satisfied with regarding synchronous online teaching.

Two hundred forty-three students completed the survey, and the response rate was 67.5% ($N = 360$). Of the 243 respondents, seven students agreed to participate in a follow-up interview

conducted in the spring semester of 2022. Descriptive demographics of the students who completed the survey are demonstrated in Table 1.

Table 1
Participant Information

	Category	*n*	*%*
Demographics			
Gender	Male	76	31.28%
	Female	167	68.72%
Grade	Freshman	86	35.39%
	Sophomore	63	25.93%
	Junior	45	18.52%
	Senior	49	20.16%
Online course experience [a]	Synchronous online class	31	12.76%
	Asynchronous online class	34	13.99%
	Hybrid	91	37.45%
	No	87	35.80%

[a] When students selected "synchronous online class" or "asynchronous online class," they indicated they had taken only that particular type of online class before. Those who chose hybrid had experience taking both synchronous and asynchronous or blended online courses.

Second, to further explore and interpret the results from the survey (Creswell & Clark, 2017) and understand students' perceptions of synchronous online learning, semi-structured interviews were conducted with students who agreed to participate in a follow-up interview. The selection of interview participants for the qualitative phase and the development of the interview protocol was based on the results of the quantitative phase. After analyzing the quantitative data, we found that both social presence and teaching presence were associated with students' level of satisfaction; thus, we decided to purposefully select interviewees according to their satisfaction with synchronous online learning. Four students were purposefully invited to participate in the interviews. Two of them were chosen from those with high satisfaction with the synchronous online course, and the other two had low satisfaction levels. Appendix B presents a semi-structured interview protocol, that was revised based on the survey results. From a phenomenological perspective (Husserl, 1962), the qualitative phase aimed to understand how students experienced the synchronous multimodal learning environment. Students were asked about how different modes had impacted their online communication and their experiences of synchronous online learning to understand why certain predictive variables differently contributed to students' stratification of synchronous online teaching. The interviews were conducted during the Spring semester of 2022. Each interview ranged from 15 to 20 minutes. Using the interview protocol as a guide, but depending on each interviewee's experiences, researchers adjusted follow-up questions to elaborate on interviewees' views and experiences. Before conducting interviews, the interview protocol was pilot tested on one student and made modifications. Using the interview protocol, one researcher conducted all interviews to ensure

that they were conducted consistently. The interviews were conducted via video conferencing and audio-recorded.

Data Analysis
Quantitative Data Analysis

R was used to analyze the quantitative survey outcomes, including demographics and participants' responses. For the first research question, descriptive statistics and analysis of variance (ANOVA) were conducted to determine whether a difference existed between different modes that impact student communication in the synchronous online environment; Tukey HSD was applied for post hoc pairwise-comparison. Regarding the second research question, Spearman's rank correlation was used to examine the relationships among multimodality, social presence, teaching presence, and satisfaction. Also, this study used multiple regression to find the predictors of students' satisfaction with synchronous online teaching and examined if social presence, teaching presence, and multimodality can predict students' satisfaction. Assumptions of multiple linear regression were tested using the data before performing the analysis, and all assumptions were met.

Qualitative Data Analysis

Two researchers coded the responses and reported the themes from the two open-ended questions to demonstrate students most favorite and least favorite parts of synchronous online learning. To analyze the interviews, researchers transcribed verbatim the recordings and followed Corbin and Strauss's (1990) guidelines in interview data analysis. First, two researchers coded two interviews independently to generate a list of initial codes and definitions. Then, the two researchers compared and discussed the list of codes to ensure both of them agreed with the code definitions and made necessary changes to the coding. Using the agreed codes and definitions, the researchers proceeded to code the rest of the interviews. Each interview was coded by two, and the constant comparative method (Glaser & Strauss, 2017) was adopted during the coding process. Codes were further analyzed to categorize them into themes by two researchers (Merriam & Tisdell, 2015). The researchers compared codes and themes to determine similarities and differences, revisited the raw data, and made necessary adjustments by modifying, realigning, and refining the codes and themes until 100% agreement on the codes and themes was achieved to enhance trustworthiness (Miles et al., 2013). Additionally, trustworthiness was also secured by member checking (Creswell & Poth, 2016); the summary of the findings was sent to the interviewees for checking.

Results

Impacts of Different Modalities

Descriptive statistics demonstrated that the communication modes represented in the survey questions impact student communication in the synchronous online environment differently. Table 2 summarizes the effectiveness of the different modes on communication. The students benefited most from the written language provided by tools such as chat boxes, while visuals influenced their communication the least.

Table 2
Multimodality on Communication

	Mean	SD
Visuals	3.16	0.83
Written language	3.55	0.71
Spoken language	3.42	0.8
Bodily behaviors	3.34	0.84

A one-way between subjects ANOVA was conducted to compare the effects of four modes on communication, which presented a significant difference between groups (F (3, 968) = 10.11, $p < .001$). Comparisons of means using the Tukey HSD test are summarized in Table 3, indicating that there were significant differences between written language and visuals ($t =$ 5.365, $p < .001$), spoken language and visuals ($t = 3.633$, $p < .01$), and bodily behaviors and written language ($t = -2.838$, $p < .05$).

Table 3
Differences in Means for the Four Modalities

Contrast	Mean Difference	SE	95% CI
Visuals versus Written Language	0.389***	0.072	0.202, 0.576
Visuals versus Spoken Language	0.263**	0.072	0.077, 0.450
Visuals versus Bodily Behaviors	0.183	0.072	-0.003, 0.370
Written Language versus Spoken Language	-0.126	0.072	-0.312, 0.061
Written Language versus Bodily Behaviors	-0.206*	0.072	-0.0392, -0.019
Spoken Language versus Bodily Behaviors	-0.08	0.072	-0.267, 0.106

*** $p<0.001$, ** $p<0.01$, *$p<.05$

Relationships Between Multimodality, Social Presence, Teaching Presence, and Satisfaction
Spearman's rank correlation was used to examine the relationships among multimodality, social presence, teaching presence, and satisfaction. The findings revealed that all correlations were positive and statically significant (see Table 4). Specifically, two modes (i.e., visual and bodily behaviors) were moderately correlated with the social presence, teaching presence, and students' satisfaction with synchronous online teaching, while the other two modes (i.e., written language and spoken language) were strongly correlated with the social and teaching presence, but moderately correlated with online teaching satisfaction. Meanwhile, both social presence ($r =$ 0.589, $p < .01$) and teaching presence ($r = 0.566$, $p < .01$) were strongly correlated with online teaching satisfaction.

Table 4
Correlations for Multimodality, Social Presence, Teaching Presence, and Satisfaction

Variable	1	2	3	4	5	6	7
1. Written Language							
2. Visual	0.514**						
3. Bodily Behaviors	0.554**	0.805**					
4. Spoken Language	0.582**	0.559**	0.574**				
5. Social Presence	0.511**	0.360**	0.393**	0.529**			
6. Teaching Presence	0.559**	0.444**	0.474**	0.589**	0.699**		
7. Satisfaction	0.422**	0.384**	0.379**	0.346**	0.589**	0.566**	

** $p<0.01$

Previous studies (e.g., Garrison & Arbaugh, 2007) discovered that teaching presence could determine student satisfaction with online learning. This study used multiple regression to find the predictors of student satisfaction with synchronous online teaching. The results of multiple regression analysis showed that $R^2 = 0.4908$, suggesting that the predictive variables can explain 49.08% of the variance in the dependent variable (satisfaction) ($F = 37.92, p < .001$). As revealed in Table 5, both teaching and social presence predicted student satisfaction with synchronous online teaching. However, regarding different modes, only spoken language was a statistically significant predictor.

Table 5
Regression Analysis for Teaching Presence, Social Presence and Multimodality and Satisfaction with Synchronous Online Teaching

Effect	Estimate	ES	95% CI		p
			LL	UL	
Intercept	-0.748	0.511	-1.754	0.259	0.145
Teaching Presence	0.918	0.207	0.511	1.325	0.000***
Social Presence	0.964	0.171	0.627	1.301	0.000***
Written Language	0.201	0.152	-0.099	0.501	0.189
Visual	0.147	0.169	-0.185	0.480	0.383
Bodily Behaviors	0.152	0.169	-0.181	0.485	0.368
Spoken Language	0.336	0.143	0.054	0.618	0.019*

*** $p<.001$, * $p<.05$

Students' Perception and Experiences

Regarding the open-ended questions, students were asked what aspects of the synchronous online class they liked. As shown in Table 6, the most frequent code was convenient, accounting for 35.02%, and 13.23% of codes ($n = 34$) represent social presence. Students responded that they were more likely to communicate in the online environment and felt less nervous. For instance, one student wrote, "I can freely express my own opinions in online class." Another responded, "It is less nervous to answer my instructor's questions in online class, and more students have the opportunity to answer the question." Besides, 10.89% of

codes ($n = 28$) related to the multiple modes of communication available in their online classes facilitated communication with peers and teachers. For example, one student wrote, "I could type in my thoughts and opinions while having the class and simultaneously displays the comments on everyone's video screen." Another student reported, "I was more confident to express my thoughts in the online class because I can see others through the webcam." Moreover, 9.73% ($n = 25$) of the codes represent teaching presence.

Table 6
Students' Satisfaction and Unsatisfaction of Online Learning

Codes	Frequency	
	n	*%*
Satisfaction		
Convenient	90	35.02%
Social Presence	34	13.23%
Affective Expression	5	14.71%
Open Communication	25	73.53%
Group Cohesion	4	11.76%
Multiple Modes	28	10.89%
Flexibility	27	10.51%
Teaching Presence	25	9.73%
General	9	36.00%
Direct instruction	11	44.00%
Design and organization	4	16.00%
Facilitation	1	4.00%
Others	22	8.56%
No	22	8.56%
Self-efficacy	9	3.50%
Unsatisfaction		
Lack of Self-efficacy	52	20.31%
Technical issues	47	18.36%
Teaching presence	40	15.63%
Social presence	38	14.84%
No	31	12.11%
Others	18	7.03%
Modes	23	8.98%
Not motivated	4	1.56%
Not convenient	3	1.17%

Note: n represents the number of codes; % represents the proportion of codes

In terms of unsatisfied aspects of synchronous online learning, the most frequent code was lack of self-efficacy ($n = 52$, 20.31%). Students also reported that technical issues ($n = 47$, 18.36%) are one of the most bothersome aspects of synchronous online classes. Among the

unsatisfaction reasons, modes accounted for 8.98% of the codes, and some students reported that physical face-to-face communication was still missing in the synchronous online learning environment.

Four students (three female and one male) were invited for a semi-structured interview (see Table 7). Two of them had low satisfaction levels with the synchronous online courses they took while the other two had a high level of satisfaction.

Table 7
Demographics for Interview Participants

	School Year	Gender	Technological skills and experiences	Online course experiences before the pandemic	Satisfaction level
Student A	Junior	Female	Good	No	Low
Student B	Junior	Male	Good	Yes	High
Student C	Sophomore	Female	Good	No	High
Student D	Junior	Female	Moderate	No	Low

Five major themes emerged from the qualitative analysis of the interviews regarding student perceptions of the impacts of multimodality on their experiences with synchronous online classes: (a). Multimodality supports social presence and communication with peers, (b). Closer visual distance between the instructor and students improves teaching presence, (c). Multimodality provides teachers with more ways to facilitate students and demonstrate learning materials, (d). Online mode impacts instructors' instructions, (e). Lack of affective belonging in the online classes.

Theme 1: Multimodality Supports Social Presence and Communication

The major theme from the interview data was that multi modes of communication supports social presence and communication. A majority of participants reflected that they could use the multiple modes of communication online to show support and acknowledge the presence of peers, as shown in the following quotes. For example, student A stated, "The chat is a good way for us to communicate online. Although I cannot meet my classmates in person, I feel I am studying with them." Student C also commented:

> If other classmates were talking, I would nod my head, like that, to show my support if I agreed with them. I don't think this could happen in the classroom…But maybe I think that when I'm online, because other classmates can see my face, they can see my support. So I would love to have that feedback.

Worth mentioning is that, among the four participants, Student B was the one who had previous experience taking an online course. He described:

> I used to take a (self-paced) asynchronous online course before; in that course, I watched videos by myself and did some assignments. I like that format as well, but sometimes I wanted to collaborate with others and discuss problems with other students…Unfortunately, in asynchronous, I am unable to do that, but in the (synchronous) online class, I can send chat messages to my friends.

Based on the response of student B, a reason the student in synchronous online classes had a higher satisfaction level might be due to the sense of social presence and being connected after taking asynchronous self-paced online classes.

The participants also expressed that the multiple modes online provided them with more ways to interact and communicate with peers in online classes, as indicated in the following quotes. For example, student D stated, "When my classmate is talking, other students can also express their opinions in the chat, contributing to the discussions." According to student C,

The multiple modes in the synchronous online course are good since I have various choices. I did not use all the modes to communicate, but at least I have some options.

Theme 2: Closer Visual Distance Between the Instructor and Students Improves Teaching Presence
Students noted that their perceived physical distance with the course instructors was much closer in the online environment than in the classroom. In particular, the physical distance between students and the course instructor was too great for those attending lecture courses in the big lecture hall. Students could not see the instructor's facial expressions and maintain eye contact. Hence, some students believed that the online format provided a closer visual distance. As a result, it might help them perceive the instructor's teaching presence is promoted through online direct instructions. According to student A,

But regarding learning knowledge, I think online classes are okay because I feel that my teacher is closer to me. It's more like talking to myself one-on-one. In the face-to-face classroom, I used to feel that my teachers were far away from me, and I couldn't have eye contact and see their facial expressions.

Theme 3: Multimodality Provides Teachers with More Ways to Facilitate Students and Demonstrate Learning Materials
In comparison to in-person classes, students also noted that the online classes offered instructors different ways to demonstrate course content and teaching materials. Some students stated that the online format compelled instructors to use more technology; to some degree, integrating technology makes teaching more fun and effective. Student B noted, "I think taking classes online gives teachers the opportunity to use different technological tools to present the course content, which actually makes the content more vivid."
Additionally, multimodality enhanced student engagement in the online class since the instructor could apply multiple modes for students to participate, such as emoticons and chat. On the other hand, students can ask questions in multiple modes and receive instructors' in-time feedback. Student C reflected:

One good thing is that in the online class, we can use chat to come up with some ideas or some quick answers to questions.…I think it was very engaging.…I think online classes provide multiple channels for everyone to communicate and exchange. In the classroom, this form is relatively simple; that is, the teacher talk and the students answer.

Similarly, student D also mentioned, "If I have questions, I would love to unmute myself to ask. I felt it is more convenient to ask questions in the online class, and I can get my teacher's feedback timely."

Theme 4: Online Mode Impacts Teachers' Instructions

The participants also noted that, unlike face-to-face in-person classes, instructors in online courses need to deal with different teaching modes, such as sharing a screen to show PowerPoint slides and tracking if there are any questions in the chat. Those multiple-tasks online impacted the instructor's teaching. As one student stated, "Sometimes, I can feel that my teachers are busy or frustrated in teaching, which may impact their teaching, they cannot focus. They need to answer the chat, control PPT, move around screens, and so on." To some degree, the students believed that the multiple tasks in online classes decreased teachers' quality of instruction. They also pointed out that if a teaching assistant provided support for the instructor, it would be helpful. However, not all their classes have a teaching assistant; most of the time, the instructor must control everything. The students mentioned that the technical issues faced by online teaching instructors also influenced their instructions. For example, one student pointed out, "Teachers' instruction is a little different. We need to log in to the meeting room, and sometimes my teacher has some technical issues, which waste a lot of time."

Theme 5: Lack of Affective Belonging in Online Classes

Students also noted that even though they met synchronously face-to-face in the online class, they still felt isolated. In particular, they believed that seeing each other played an essential role in social connections. If other students turned off the camera, they could not have good communication experiences and feel isolated and lonely in class. For instance, one student emphasized that "Seeing my classmates' faces can also enhance our bond." Thus, online learning experiences lacked affective belongings. This was also a critical factor that made them miss the in-person learning experience. However, the affective belonging was better, and they could feel they were studying together with peers instead of studying alone. For example, student D stated, "some of my classmates did not turn on their camera when having online classes, so sometimes I feel I am having a class alone online and can only hear and see my teacher." Student C also mentioned:

> I would prefer to turn my camera on, and my classmates can turn the camera on too. I can feel that we are sitting in the same room. But in reality, not everyone in the class turns the camera on. I felt a little bad when I need to talk to black screens, instead of seeing everyone's face.

Discussion

The Impacts of Different Modes of Communication

The quantitative findings of this study revealed that the modes of communication impacted students' interactions in synchronous online classes differently. More specifically, written and spoken languages were privileged in synchronous online communication, which aligns with Hoffman's (2018) findings that those two modes dominate synchronous online communication. In the interview, students indicated that multimodality supported communication with peers and instructors because in synchronous online classes they can use

multiple modes to communicate. As indicated in previous literature, a wider range of communication modalities copes better with different students' interaction preferences (Angelone et al., 2020; Wang & Huang, 2018). According to a participant, "when my classmate is talking, other students can also express their opinions in the chat, contributing to the discussions." Besides, visual and bodily behaviors could play important roles in supporting student online communication since these behaviors reduces psychological distance and positively influences student participation (Bozkaya, 2008), which is also reflected in the interviews. For example, students emphasized that they could nod their heads and use facial expressions to support their peers and express their opinions. Additionally, the multiple channels supported by technology in the synchronous online environment made it possible for students to have real-time communication in different ways due to reduced physical distance (McBrien et al., 2009). Overall, the diverse choice of communication channels for written and spoken languages provided by the instructors could benefit distance students and enhance their online learning communication.

Furthermore, this study indicated that multimodality played a role in creating a sense of belonging in the online learning environment. Given participants' comments on their feelings of togetherness and involvement, seeing each other made them feel they were studying together. These results can be explained by the fact that people feel social connectedness to others if they believe they are doing the same things simultaneously (Marsh et al., 2009), which enhances affiliation (Lumsden et al., 2014). In this study, students expressed that they acknowledged agreement, showed their support in the online learning environment by using different modes, and felt involved in the interaction when their peers responded as well. Therefore, instructors need to cultivate an atmosphere that allow learners to feel that their online peers are participating in the classes and are involved in the communication (Satar, 2015).

The Relationships Between Multimodality, Social Presence, Teaching Presence, and Satisfaction

The results showed significant positive correlations between students' perceived effectiveness of all four modes of communication, social presence, teaching presence, and satisfaction. Moreover, the regression outcomes showed that social presence, teaching presence, and spoken language were significant indicators of satisfaction.

The significant positive correlation comports with the study conducted by Garrison (2009), indicating that the more effectiveness students perceive of each modality, the more they will be willing to communicate purposefully and develop inter-personal relationships. The context of this study was synchronous online courses, which differ from asynchronous online courses in that students can see and communicate in real-time (Hoffman, 2018; Peterson et al., 2018). Students in the interviews reported that seeing their peers during the class helped them improve social presence: "I would like to see everyone's face and other body behavior. So if I can see those, they will help me feel more confident when answering questions." Another student mentioned the benefits of visible bodily gestures via real-time online tools: "If other classmates were talking, I would nod my head, like that, to show my support if I agreed with him/her…. I would love to have that feedback." These results resonate with Satar (2020) who claimed that video conferencing tools, such as Zoom, provide opportunities for real-time peer interaction, and thus enrich learning experiences. In addition, students in synchronous online contexts can also chat in real-time (written language): "sometimes I wanted to collaborate with others and discuss problems with other students, like how we did in classrooms. Unfortunately, in asynchronous, I

am unable to do that, but in the online class, I can send chat messages to my friends." This outcome echoes the previous finding that written language is crucial in supporting students' synchronous online communication (Hoffman, 2018). The more students perceived multimodalities such as gestures or real-time chat as effective, the more they would be involved in interpersonal interaction (Cunningham, 2014).

Furthermore, students' perceived effectiveness of multimodalities is significantly correlated with teaching presence. Students mentioned in the interviews that implementing multimodality enhanced teacher presence during synchronous online courses since it decreases the "distance" of online learning environments which improves students' perceptions of teaching presence (McBrien et al., 2009). For instance, students indicated that the proper application of visuals allowed teachers to present the learning materials better: "I think taking classes online allows teachers to use different technological tools to present the course content, which actually makes the content more vivid." This outcome is similar to the findings from Tichavsky et al. (2015), that when instructors deliver a clear presentation of learning contents, students were more likely to perceive their teaching presence. Moreover, students also indicated the importance of immediacy when communicating with instructors: "One good thing is that in the online class, we can use chat to come up with some ideas, or some quick answers to questions." In fact, communication immediacy is significantly, positively associated with teaching presence (Baker, 2010). Thus, supported by the effectiveness of multimodalities, immediate feedback enhance students' perceived teaching presence, which indicates instructors should employ multimodalities to improve communication immediacy.

In addition, increased modality choices during learning practices could be the reason for positive correlation between students' perceived effectiveness of multimodalities and social and teaching presences. As a student mentioned: "The multiple modes in the synchronous online course are good since I have various choices. I did not use all the modes to communicate, but at least I have some choices if I want to say something." The multimodal environment of the synchronous online courses provided students with enriched learning environments (Hoffman, 2018; Peterson et al., 2018): "I think online classes provide multiple channels for everyone to communicate and exchange. In the classroom, this form is relatively simple; that is, the teacher talks, and the students answer." The synchronous online environment with various modality choices influenced students' behavior and perception of social and teaching presence. As indicated by Wang and Huang (2018), the flexibility of choosing the most comfortable modalities could foster learners' interaction with peers and instructors, which explains the positive correlation between their perceived effectiveness and social and teaching presence. An implication for instructors is that various modalities should be given to learners based on their preferences to maximize learning efficiency.

The regression analysis showed that social presence, teaching presence, and spoken language predicted satisfaction. For social presence, as indicated by Bolliger and Martindale (2004), students should be given functional, usable tools for interaction and should be provided with plenty of opportunities to participate in discussions to feel involved and promote satisfaction. This outcome resonates with the correlational results that different modalities are positively correlated with social presence and satisfaction. Teaching presence is also a significant predictor of satisfaction, which resonates with previous studies (Bray et al., 2008; Kuo et al., 2014), that teaching presence determines the intensity and frequency of feedback and support students receive, which impacts their satisfaction.

Although all four modalities were correlated with satisfaction, only the spoken language was a significant predictor of satisfaction. These findings supplemented previous literature about the associations between modalities and learner satisfaction (Abuhassna et al., 2020; Landrum et al., 2021; Malkawi et al., 2020). Student interviews shed some light on the role of spoken language relating to their satisfaction, for example: "I unmute myself sometimes to answer questions, and if I had questions, I would love to unmute myself to ask. I felt it is more convenient to ask questions in the online class, and I can get my teacher's feedback timely." This finding indicates synchronous online learning supported by real-time video conferencing tools provides students opportunities to interact with peers and instructors in a way that is comfortable for them (Angelone et al., 2020). In other words, students were given choices about the best way for them to communicate, which in return could yield greater social presence (Wang & Huang, 2018). As a student mentioned: "If I am in class, I may not dare to go directly (ask teacher questions), but in front of the computer, I will feel less embarrassed and nervous. I don't need to wait till class ends to ask questions." This finding suggests that to cultivate a more positive learning experience and higher satisfaction, students should be given greater flexibility in verbal communication approaches throughout the learning process.

Conclusion

Synchronous online classes differ from both in-person and asynchronous online classes in terms of communication modes, which provide students with multiple modes to communicate (Hoffman, 2018) and offer students a different learning experience. Thus, it is worth investigating how the various modalities affect students' communication in the synchronous online teaching environment and how that relates to their online learning experience. This study applied a mixed-methods approach to research and presents a holistic overview of how four different modes (i.e., visuals, written language, spoken language, and bodily behaviors) have impacted students' online communication in the synchronous learning context, as well as the relationship with social and teaching presence, and their satisfaction with synchronous online learning. The findings of this study could provide implications for instructors to adopt a variety of modes to promote students' communication with peers and instructors, which enhances teaching presence and give students greater satisfaction with online learning. In addition, the outcomes supported the importance of social presence and teaching presence in synchronous online learning and contributed to the growing body of literature that examines online learning with the community of inquiry framework.

Limitations

Self-report survey data was used in this study to measure the impacts of multimodality on students' online learning experiences. However, there are limitations to using self-reported data (Rosenman et al., 2011). Although self-reported data offer some insights into the phenomenon, they may not provide the full picture of how multimodal impacts students' online interactions. Thus, the analysis of class video recordings may be employed in future studies to examine the interactions in class. Also, in our future study, we will use multiple items to assess students' satisfaction with synchronous online learning instead of a single-item scale to ensure reliability. Additionally, because we did not recruit participants from a particular course for our study, we could not examine how instructors' teaching pedagogies impacted students' learning. In future studies, instructors' pedagogical choices could be explored as a variable in relation to students' learning of multimodal communication. Another limitation of this study is that only four modes

were analyzed. In future studies, a comprehensive analysis of the different modes could be conducted to fully understand how multimodal impacts students' learning in an online environment.

Declarations
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The authors assert that approval was obtained from an ethics review board (IRB) at the University of Texas at Austin, USA.

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Appendix A
Survey

Question1:
Gender Identification:

Question 2: Please rate your knowledge about technologies before Spring Break 2020, when classes were conducted in a face-to-face setting.
   a. Very poor
   b. Poor
   c. Acceptable
   d. Good
   e. Very good

Question 3: Before Spring Break 2020, did you take any online courses? [Select All That Apply]
   a. Yes, synchronous online courses
   b. Yes, asynchronous online courses
   c. Yes, blended online course
   d. No

Please answer the following questions based on your online learning experience.
1= strongly disagree, 2=somewhat disagree, 3=neutral, 4=somewhat agree, 5=strongly agree

Multimodal Communication
Question 4:
In my synchronous online classes:
   1. The online chat, emoticons, and icons increase the communication between me and my classmates
   2. Visuals, including eye contact, and the course materials (such as images, and videos) screen shared by the instructor increase the communication between me and my classmates.
   3. Bodily behaviors, for example, body orientation, smiles, head nods, gestures, etc., can help the communication between me and my classmates.
   4. Talking through microphones can help communication between me and my classmates.
   5. The online chat, emoticons, and icons increase the communication between me and instructor.
   6. Visuals, including eye contact, and the course materials (such as images and videos) screen shared by the instructor increase the communication between me and instructor.
   7. Bodily behaviors, for example, body orientation, smiles, head nods, gestures, etc., can help the communication between me and instructor.
   8. Talking through microphones can help the communication between me and instructor.

Teaching presence
Design and organization
Question 5:
In my synchronous online classes:
1. The instructor clearly communicated the course topics.
2. The instructor clearly communicated the learning objectives of the course.
3. The instructor clearly provided instructions on how to participate in the course activities.
4. The instructors clearly provided instructions on how to prepare for the course exams/tests.
5. The instructor clearly stated the due time for tasks.

Facilitation
Question 6:

In my synchronous online classes:

1. The instructor illustrates the learning topics that helped my understanding.
2. The instructor kept students engaged in productive interaction.
3. The instructor kept students on tasks in a way that helped me to learn.
4. The instructor encouraged students to explore new ideas in the course.
5. The instructor reinforced the development of a sense of community among students.

Direct Instruction
Question 7:

In my synchronous online classes:

1. The instructor helped students focus discussions on relevant issues in a way that helped me to learn.
2. The instructor provided feedback that helped me understand my strengths and weaknesses relative to the course goal and learning objectives.
3. The instructor provided feedback in a timely fashion.

Social Presence
Affective Expression
Question 8:

In my synchronous online classes:

1. Getting to know other classmates gave me a sense of belonging to the course.
2. I was able to form distinct impressions of some classmates.
3. Online or Web-based communication is an excellent medium for interaction.

Open Communication
Question 9:

In my synchronous online classes:

1. I felt comfortable communicating through the online platform.
2. I felt comfortable participating in the course discussions.
3. I felt comfortable communicating with my classmates.

Group Cohesion
Question 10:

In my synchronous online classes:

1. I felt comfortable disagreeing with my classmates while still maintaining a sense of trust.
2. I felt that my point of view was acknowledged by my classmates.
3. Course activities helped me develop a sense of collaboration.

Question 11:

Please rate your experiences of the synchronous online courses (from 1-Extremely dissatisfaction -10 extremely satisfaction)

Question 12:

What was the most satisfying part of synchronous online learning?

Question 13:

What was the least satisfying part of synchronous online learning?

Appendix B
Interview Protocol

1. Can you tell me about yourself?
   (e.g., educational background, technological skills)
2. Describe your experience with online learning during the pandemic.
   a. How did it go for you? [prompts: difficult, easy; why?]
   b. What were the major differences between learning online and in the classroom?
   [prompts: teachers' instruction? Organization? Your communication?]
3. Describe your experience using the different modes in the online class?
   [prompts: Chatbox, Videos, Microphones, others]
   a. What worked for you? Why?
   b. What did not work for you? Why?
   c. Do you believe the different modes impact your communication with peers/instructors in synchronous online course?
4. Describe your experiences of online communication with your classmates?
   [prompts: any difficulties, why? Compared with in-person communication]
   If you want to communicate with your peers, which modes would you choose? (Chat, unmute yourself?)
5. Describe your experiences of online communication with your course instructors?
   [prompts: any difficulties, why? Compared with in-person communication]
   If you want to ask a question or communicate with your teacher, which modes would you choose? (Asking questions in chat, or unmute yourself?)
6. What did you like best about synchronous online learning? Why?
7. What did you like least about synchronous online learning? Why?

Appendix C
Coding Scheme

Table C

Coding Scheme Adopted in Interview Transcripts and Emerged Themes

Themes	Codes	Descriptions
1. Multimodality supports social presence and communication with peers	Support and encourage	Use of text chat, emoticons, and icons (such as clapping icons), accompanying gestures, and head movement for support and encouragement
	Acknowledge the presence of others	Use of text chat, emoticons, body language, facial expressions to acknowledge the presence of others
	Use multiple modes to communicate	In the online class, students can use multiple modes to communicate with peers
	Contribute to the interaction	Use of text chat, emoticons to interact when others are speaking
	Promote participation	Multiple modes online provided introverted students more opportunities to participate
2. Closer visual distance between the instructor and students improves teaching presence	Make eye contact	Students can have eye contact with teachers when having classes online
	Feel closer in online mode	The perceived distance between instructor and students is closer
	Give direct instructions	Students perceive instructor's teaching presence through their online direct instructions.
3. Multimodality provides teachers with more ways to facilitate students and demonstrate learning	Demonstrate content	The online multimodal environment provides instructors with different ways to demonstrate course content and teaching materials
	Enhance engagement	Multimodality provides instructors with ways to enhance students' engagement in the online class
	Allow students to ask questions and receive feedback	Multiple communication modes online allow students to have more ways to ask questions and receive instructors' feedback timely
4. Online mode impacts teachers' instructions	Utilize different teaching modes	Compared with in-person classes, instructors need to deal with different teaching modes
	Come across technical issues	Instructors face technical issues in online teaching
5. Lack of affective belonging in the online classes	Highlight the importance of visual	Visual plays an important role in social connections in the online class
	Feel isolated and alone online	Students feel lonely in online class