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ABSTRACT

Starting from the spring of 2020, higher institutions in the US underwent a rapid shift from in-person classes to emergency remote education, in response to the COVID-19 outbreak. Under this circumstance, a variety of video conferencing tools (e.g., Zoom) have been adopted for distance education, which pose a set of new challenges arising from synchronous online classes. Among these, one significant issue was students' unwillingness to open cameras, resulting in a lack of non-verbal cues that instructors could rely on to gauge students' understanding and adjust their teachings. Towards addressing this issue, our qualitative study aims at investigating the rationales behind students' camera avoidance. Through a series of semi-structured interviews on undergraduate students in the U.S, we identified prominent factors – namely the class size, lecture style, level of interactivity and privacy concerns – that influenced students' motivation for opening their cameras. At the same time, we uncovered several difficulties, such as heightened self-awareness, feeling of minority and academic perspective, that discouraged students from opening camera, with more substantial impacts on international students. We conclude with actionable insights into the design of online classes, video-conferencing platforms and camera technology that can promote camera usage, thereby contributing to scalable and inclusive interventions for facilitating the transition into remote education.

CCS CONCEPTS

· **Human-centered design**; • **Empirical studies in HCI**;

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KEYWORDS

Camera usage, Emergency online learning, Domestic students, Inter- national students, Zoom, Semi-structured interview, Digital privacy

1 INTRODUCTION

The COVID-19 pandemic resulted in an unprecedented global crisis, bringing a sweeping wave of disruptions throughout education [6], health systems and economies [63] in our society. Among these changes, higher institutions were vastly affected [49]. To ensure the safety of students and instructors, the traditional in-person teaching paradigm was replaced by a virtual learning paradigm [3, 14]. This rapid shift to distance education prompted higher institutions to adopt a variety of video-conferencing tools [29, 30, 41] such as Zoom, Microsoft Teams, and Google Meet [4] on which remote education was carried out. While the end of 2020 and the beginning of 2021 promised (and delivered) a return to in-person education, the new *Omicron* variant [11] has made emergency online education a necessity again. For example, some US universities returned to remote education for a few weeks in the spring of 2022 when the Omicron cases surged earlier in the same year [17]. This trend, in turn, raises the need for further studies on understanding and facilitating emergency online education.

On the surface, online education offers the best of both worlds: students can study from the comfort of their home [59, 80], while universities can maintain their curriculum to an extent of normalcy. However, online learning platforms also result in a new set of challenges to both teaching and learning, exacerbated by the scale at which they have been adopted during the pandemic. For example, instructors faced difficulties in adapting to remote education and delivering high-quality instruction [1, 55, 80], while students reported decreased motivation, technical issues

and inadequate communication with teachers [2]. These challenges can be attributed to, among other factors, students' hesitance to turn on their camera while attending synchronous online classes via video-conferencing software such as Zoom [10]. This behavior deprives instructors of non-verbal cues which they often rely on to evaluate students' understanding and adjust their teachings [10]. Furthermore, it removes the student-teacher connection, typically induced from face-to-face interaction, that could promote students' learning motivation and sense of belonging [35, 46, 62]. Without opening their cameras, students could hardly see and engage with classmates in a way that simulates the in-person learning experience [46].

While the seemingly obvious solution to these issues is requiring that all students turn on their camera during online classes, doing so without a clear understanding of students' source of hesitation may prove counter-effective. Prior surveys have identified several potential causes, such as concerns of self-appearance and privacy, unstable internet connection, and avoidance of peer judgment [10, 34, 39, 62, 76]. However, while this body of research has typically focused on identifying the common sources of camera avoidance among students, there is also value in examining how these sources differ from individuals to individuals. Our rationale is that students' online learning experience is shaped by not only the learning platforms themselves, but also diverse personal and educational traditions that are unique to each individual [78]. This diversity further implies that there will not be a one-size-fits-all solution to students' camera avoidance; instead, instructors ought to look into individualized interventions, taking into account each student's background.

Our research seeks to provide a foundation for this individualization, by examining and comparing the online learning experience of students with different backgrounds. While there are many potential background factors to consider, in the scope of this work, we focus on college students in the US and consider whether they were born in the US (domestic students) or came to the US to study abroad (international students). Our rationale for this categorization is that the US has one of the largest populations of international students in the world, with around 1.1 million international students enrolled in higher institutions from the academic year 2019-2020 [33]. Furthermore, international students likely felt the largest impact of the transition to online education, being distant from both families in their home countries and from their peers in the US [38, 86]. Therefore, we hypothesize that their concerns with camera usage may differ from those of domestic students and merit additional attention.

To examine this topic, we conducted 13 semi-structured inter- views with both domestic and international students to understand the commonalities and discrepancies between them in terms of camera use practices and the underlying reasons for such practices. In doing so, our research contributes to the following areas:

- An understanding of students' camera use practices during emergency online learning. Through our analyses, we report their experiences, reasons behind camera use in different classes and situations.
- An understanding of commonalities and differences between domestic and international students regarding camera use.
- Providing insights and recommendations into the design of online classes and platforms.
- Providing design implications to improve camera technology as well as the security of video-conferencing platforms.

2   RELATED WORK

In this section, we first discuss the related work about the importance of camera technology in emergency online classes. Following that, we expand on the objective self-awareness theory as well as its influence on students' camera use behaviors. Finally, we examine international students' learning experience and challenges in the US, and discuss how these extra challenges might contribute to their ideas and experiences with camera usage during emergency online learning.

2.1   Camera Use in Emergency Online Education

After the sudden outbreak of COVID-19 pandemic in the spring of 2020, most higher institutions in the US have abruptly shifted to "emergency synchronous online instruction" [26]. Compared to in-person classes, synchronous online education posed a number of new challenges for instructors and students to teach and learn. For example, students were not so motivated or engaged in online classes as in face-to-face classes [72, 80], and it is easy for them to grow bored or feel fatigued by Zoom [34, 57] after staring at screens for a long period of time without personal interaction [32]. Faculty also had trouble in adapting to online mode of teaching. For example, some instructors who were not tech-savvy found it demanding to handle online course delivery, and they also lack effective support from

universities in training them how to teach online [70]. Amid all the difficulties, one noticeable issue is that students did not open their cameras when taking synchronous online classes held via video-conferencing tools [10]. With cameras on, students and instructors could see each other, contributing to building up a closer relationship between them [15]. Moreover, opening cameras allows instructors to receive nonverbal cues from students such as smile, head nodding, frown, confusing looks to evaluate and adjust their teaching accordingly to help students understand course content [53, 58]. However, instructors would feel lonely and displeased if they "talked to themselves" without seeing students' faces in the cameras [10, 64].

A few recent studies reported the reasons why students were not willing to open cameras in online classes during the COVID pandemic. Through surveying undergraduate students, they found that 41 percent of students turning off cameras in online classes was due to their concerns about self appearance, weak internet connection [10]. Other reasons include teacher-student relationship, lack of necessity of using cameras when audio is available etc [5].

In addition, privacy was reported to be the major factor resulting in camera avoidance in prior studies. Over 88 percent of students were against using cameras due to their concerns about privacy [67]. Similarly, another study also reported that all student participants and their parents share the concern that students' digital privacy will be threatened if they use camera technology in virtual classes [36]. For example, as a popular video-conferencing platform for emergency distance education, Zoom has suffered from different privacy and security issues such as Zoom-bombing, pranking in Zoom classes, and a lack of users' data protection [20, 54].

Although it is beneficial for instructors to teach with students turning on cameras, to our best knowledge, only a few prior works [10, 10, 67] have explored students' camera use issue in distance education during COVID-19 period. Besides, all these studies used surveys to investigate the reasons behind students' camera on/off. In this study, we conducted in-depth interviews to deeply examine not only the reasons but also how and why these reasons contributing to students' camera use. Unlike surveys, our interviews delved into the rich students' experiences and stories regarding camera use in online classes.

2.2 Objective Self-awareness Theory

Researchers have investigated psychological perspectives on the self for a long time, e.g., [52]. The Objective self-awareness theory [18, 85] is a dominant and earliest one that could explain the effects of opening cameras on students' performance. Objective self-awareness (OSA) refers to the consciousness directed toward oneself, and it is characterized by self-evaluation and introspection [18]. As Duval and Wicklund [18] put it: *"when self becomes an object of one's conscious awareness, self-evaluation will occur"*. Opposite to objective self-awareness, subjective self-awareness refers to one's attention directed toward other people or objects [18]. In addition, objective self-awareness prompts people to reconcile the discrepancy between their behavior and ideas if they are engaged in any self-contradictory behaviors. The experiment conducted by Duval and Wicklund [85] demonstrated that subjects in front of a mirror performed tasks at a higher rate than those who did not see their images, because people seeing themselves in mirrors trying to self-evaluate their performance and correct their behavior to match the standard. In our study, the objective self-awareness theory could inform that, when opening cameras in class, students who are in the presence of others attempt to take efforts to reach the standard and try to behave correctly [18, 19, 74], or they might close cameras to avoid seeing themselves, thus ending self-evaluation and correctness behavior [9, 21, 85].

In addition, it is important to note that opening cameras in virtual classes could lead to objective self-awareness in students, which would give rise to their anxieties due to constantly being watched by other remote people [48, 69]. To address situational anxieties, an ever-growing body of experimental studies have proved the effectiveness of systematic desensitization technique that was initially developed to remove conditional fears in animals [87]. The typical approach used in systematic desensitization is exposing sub- jects to anxiety-producing situations from the least anxious to the most [22]. For example, one previous experimental study adopted systematic desensitization to address students' test anxieties by exposing them to anxiety-producing situations from low capacity to high capacity [68]. Other studies also examined the success of systematic desensitization in reducing speech anxiety [51], social anxiety [8] and math anxiety [71].

Although objective self-awareness theory has been studied extensively in experimental studies using mirrors, few empirical studies examined how students react to a stimuli (video-

on) that prompt objective self-awareness in the context of *virtual online classes*. Besides, none of the previous studies examined the influence of objective self-awareness on students from diverse backgrounds.

To address this research gap, we interviewed five domestic students in the US, and eight international students who stayed in the US for a short time (less than 3.5 years). We are interested in comparing the domestic students and international students in terms of their reactions and behaviors after looking at their images in cameras in virtual classes, thereby helping us understand the impact of objective self-awareness on their use of cameras.

2.3 International Students in the US

When studying in the US, international students are confronted with different plights such as language barriers that hindered smooth communication between them with native speakers [89], real or perceived discrimination resulted from minority race [91], lack of social support [90], culture shock [24] etc. Previous studies dis- closed that international students experienced English language insecurity, which led to their stress and anxiety when living in a foreign country [81]. In online classrooms, recent studies showed the effect of linguistic and cultural factors (e.g., modesty) on camera use in online learning [28]. Besides, some international students suffered from financial and residential problems [73]. The challenges confronted in a foreign country might give rise to their unique experience with camera usage in emergency online learning. There- fore, our study aims to explore the differences or nuances between international students and domestic students.

Through our literature review, we identified two areas of improvement in existing research. First, little attention has been paid to understand the reasons and backstories concerning students' camera use practice in remote emergency education. Second, none of the previous studies have been conducted to analyze the camera use difference between domestic and international students. To fill these two gaps in literature, we aim to explore the different experiences that students went through during online learning and their use of cameras. Moreover, we employ the objective self-awareness theory [18] to explain the major differences between international and domestic students.

3 METHOD

3.1 Recruitment Procedure

Our study is based on a previous university-wide survey collecting feedback from instructors and students about their teaching and learning experience in the spring of 2021, at a large public university in northeastern US. Our initial pool of potential participants consists of students who agreed to be contacted for future interviews when filling out this survey. From this pool, we sent invitation emails to 100 potential candidates and proceeded to interview five students. These students were born in the US and had English as their native language; we classify this group as the domestic students. Because this initial pool only consisted of domestic students, we used another method to recruit international students – purposeful sampling on social media platforms such as WeChat and Instagram. In this way, we recruited an additional group of eight international students who were born outside the US. These students have English as their second language and have spent less than 3.5 years in the US. Demographic information about our participants is included in Table 1, where we note that the student with ID IS3 has never been to the US and has been taking online courses from her hometown in China.

Table 1: Demographic information of participants in the study.

Student ID	Gender	Country	Major	Time spent in the US
DS1	Female	US	Hospitality Management	-
DS2	Female	US	Psychology	-
DS3	Female	US	Anthropology	-
DS4	Male	US	Business Marketing and Management	-
DS5	Male	US	Computer Engineering	-
IS1	Female	Taiwan	Criminology & Psychology	3 years
IS2	Male	Korea	International Relations	1 year
IS3	Female	China	Health Policy	N/A
IS4	Male	China	Computer Science and Psychology	4 months
IS5	Female	China	Data Science	9 months
IS6	Female	Taiwan	Criminology and Psychology	3 years
IS7	Female	China	Food Science	3 years
IS8	Male	China	Biochemistry and Molecular Biology	3 years

3.2   Interview Design

Our interview protocol included 22 questions for domestic students, and 24 for international students. The questions were created to elicit students' experience about why they opened or closed cam- eras when taking online classes during the COVID-19 pandemic. Besides, we asked follow-up questions based on participants' answers to clarify information or dive deeper into their experience. The major differences between domestic and international participants in the interviews resided in the fact that international people were also asked about their learning adjustment experience in the US. Each interview lasted from 30 minutes to 55 minutes based on the amount of information the participants were willing to disclose. All the interviews were audio recorded with prior verbal consent of each individual participant. During the interviews, we started off with 4 questions related to basic information – including their country of origin, undergraduate major, classes taken during the spring of 2021, and the sizes of each class. Then, we proceeded to more in-depth questions involving (1) when they felt comfort- able/frustrated with opening cameras, (2) how they felt about their images being visible to others after opening cameras, and (3) what they did when most of their classmates opened or closed cameras. These questions sought to examine the experience and stories that participants had with camera use. Given the scope of our study, we reached data saturation [65, 84] after five interviews with domestic students, and eight with international students. As the interviews progressed, we noticed clear patterns emerging but no additional novel themes. After the interview process finished, each participant was compensated with a 15$ Amazon Gift Card.

After all the interviews were completed, we used thematic analysis to analyze the transcripts. Driven by our research interest to understand the commonalities and differences between domestic and international students concerning camera use, four authors of this paper conducted data analysis by repeatedly reading the transcripts and summarizing the major ideas related to our research interest. To achieve internal reliability [42], the four researchers took turns to analyze each transcript to achieve a consistent idea of the major findings. Through weekly meetings, we generated an initial list of codes after extensive discussions. Next, we conducted a second-round data analysis by reviewing the major themes. After multiple rounds of discussion, we decided on the major codes which illustrate the common and different reasons for domestic and international students' willingness or

unwillingness to use cameras.

4　FINDINGS

4.1　Commonalities in Camera Usage

From our interview data, we identified three distinct themes for the rationales behind students' camera usage: class characteristics, interactivity and privacy. These themes were mentioned by both domestic and international students during the interviews. All of the codes in this category are included in the appendix table 2.

4.1.1　*Class characteristics.* Both domestic and international students mentioned that they were more likely to turn off their cameras in large classes (e.g, those with more than 100 students). Due to the class size, most students would not have the opportunity to interact with the instructor. In addition, there were no clear policies around camera usage in these classes, prompting the majority of students to close their cameras. This trend, in turn, discouraged students who want to open their cameras, because doing so would make them stand out and feel uncomfortable:

> *We had 300 people in the room. It is a huge class, I think I would turn off my camera. I mean there was nobody have [sic] their cameras on. I don't want to be the only one, because everybody is, you know, going to watch me, I feel like.* - IS4

In comparison, students preferred opening cameras in small classes, especially if they have built up a certain degree of familiarity or rapport with other students. As DS1 pointed out, when taking a small math class, she was happy to turn on camera because her classmates were *"all the students I've been seeing before."* A conformity effect similar to that in large classes also emerges here: if most students already turned on cameras, others would be inclined to follow.

> *It depends on the general environment, if most people have their cameras open, then I will do it. If the instructor is the only one who has his cameras open, then I will not, I will just ask questions through the audio.* - IS8

Other than class size, class types also influenced students' camera use. For example, in physical education or public speaking class, students were either required to open cameras or strongly encouraged to do so, because in these classes, instructors have to see students' actions,

facial expressions or postures to give them feedback based on their performance. In addition, when students were tested in classes, instructors required them to open their cameras to prevent or decrease cheating behaviors.

> *If there was a reason to have it on, I'd pretty much did have it on of course for tests and then I took a PE class which we were required to turn it on for exercise and stuffing. That was normal yeah".* - DS4

The duration of the class was also brought up by both groups (domestic and international) as a deciding factor. In long classes, students may want to take occasional breaks or change their postures (e.g., from sitting on a chair to lying on a bed) without letting the instructor know, hence their decision to close their cameras.

In addition, the teaching mode, i.e., whether the class was oriented towards lectures or faculty-student discussions, played a role in the students' decision. Students from both groups agreed that they would have little motivation to open their cameras if the class was centered around the instructor's monologue. Conversely, classes that involved more active engagement, discussion and de- bate gave them more incentive to turn on cameras, so as to replicate a typical face-to-face conversation:

> *When I discussed with, like talk to people, I just feel like I want to turn on the camera. So if the classes have a discussion, no matter which class, I will turn on my camera, but if it's just completely like looking through the powerpoints. I never turn on my camera.* - IS6

4.1.2   *Interactivity.* Another situation where students (both domes- tic and international) had a strong tendency to turn on their cameras was during breakout rooms on Zoom. Breakout room is a feature that divides participants into smaller groups, sending each group to a virtual room where members can discuss in private. Students noted that being in smaller groups with classmates prompted them to turn on cameras, as not doing so may indicate an attitude of indifference – as IS6 pointed out, *"in the breakout room there will be like three people or four, so you just feel like you have to speak or engage somehow"*.

However, rather than feeling compelled, several students were willing to open their cameras because of the interactive group dynamic in breakout rooms or because they were familiar with each other. For example, having students engage in discussions could help build up a positive atmosphere where others are also encouraged to open their cameras

and share their thoughts. As IS8 noted, their primary motivation for turning on the camera was to respond to their classmate's engagement:

> *I just feel like if someone engaged in discussions, it kinds of encouraged myself to do it as well. I don't think I will turn on camera if they just turn on the camera but didn't talk or something, that still makes me hesitant to turn on [camera] or engage in a conversation.* - IS8

4.1.3   *Privacy.* Another prevalent issue among domestic and inter- national people was their concern about privacy. We found that students closed their cameras for the purpose of protecting their privacy, especially when they did not want to reveal their surround- ings. In addition, students also noted that they were mindful of their roommates if there was someone in the same room with them:

> *I have a roommate and she doesn't get up until maybe 10 or 11 and in order for me to have my video it on I need like the lights on, I didn't want to disturb her, so I closed my cameras in the morning classes.* - DS1

Furthermore, in the early days of the pandemic, Zoom rooms were not password-protected by default and could be accessed by anyone who knows or can guess the meeting ID, which is a short numeric sequence. This setting led to a phenomenon known as *Zoom-bombing*, whereby aggressors joined meetings with the intention of disrupting and harassing the participants [47]. Even though Zoom has attempted to address this issue by enabling passwords, based on our interviews, we found that students remained vigilant to the possibility of a stranger breaking into the online classroom and recording them without their consent, thereby opting to close their cameras altogether.

> *I won't open my cameras because I'm concerned about my data security. I have seen people joining the class and doing things like yelling or verbally attacking people. If I open camera, I try to have less things in the background or hide things that so that they don't tell much about my personal information.* - IS8

4.2   Differences in Camera Usage

From our interviews, we found that most domestic students (DS1- DS5) held a positive or neutral attitude towards opening camera in Zoom classes. When asked if they felt any frustration towards camera usage, these students did not believe so. Their attitude was

driven by the willingness to socialize in class (e.g., *"it's cool to see people's faces and kind of get to know them."* - DS2) and the consideration for the class instructor (e.g., *"I would feel kind of bad for him lecturing to just a bunch of names. So I'd like to turn my camera on to say 'good morning' and things like that."* - DS3).

In contrast, most international students held a passive attitude towards camera use and rarely opened cameras. IS1, for instance, indicated that she only opened camera once or twice throughout the semester. The use of negative connotations, such as "pressure" and "frustration," came up much more frequently in interviews with international students than with domestic students.

> *Some professors said "I want everyone to participate in the class, so I want everyone to open the camera" - I will feel stressed from hearing this, even just hearing it.* - IS1

Based on the responses in each group, we further inquired about their rationales to examine why this difference in attitude manifests. Our findings are consolidated into the major themes: language barrier and time zone difference, feeling of minority, academic performance, classroom expectation, objective self-awareness, and self-appearance. All of the codes in this category are included in the appendix table 3.

4.2.1 *Language Barrier and Time Zone Difference.* Students learning in a foreign country face more challenges than in their home countries. In our study, we found that international students struggled with obstacles preventing them from opening cameras. First, they faced time zone differences from synchronous online classes, having to attend lectures at inconvenient times. Two out of eight international students were taking midnight classes from China during the pandemic, with a 12-hour difference. IS3 described mid- night classes as an "awful experience" because she could not sleep at all if she had two consecutive classes during midnight. IS5 also noted that she typically dozed off during class because she could not get used to the schedule. Due to these issues, international students tended to close cameras to hide their sleepiness or discontent.

Second, international students faced language barrier which diminished their willingness to engage with the class. They either could not clearly explain their thinking or had issues with pronunciation; the latter may also be worsened by the bad audio quality resulting from a poor internet connection. To make matters worse, students were often asked by their instructors or

peers to repeat what they said if their original message did not come through; while this is a reasonable request, it further amplified their anxiety:

> *It's stressful. I think this kind of anxiety from my language barrier will prevent me from opening my camera. I felt like I won't speak, because I am already nervous about it.* - IS6

4.2.2   *Being Minority in the US.* Our data analysis also revealed that the perception of being the minority in a foreign classroom led to international students' insecurity and hesitance to show themselves on camera. IS2 described feeling "uncomfortable and awkward" when being looked at by his peers. Likewise, IS1 was under the impression that domestic students considered Asian students as being difficult to communicate with, hence her reluctance to open up:

> *Sometimes I feel a bit insecure because I'm Asian. I am not the majority of students in the class. So I feel a bit insecure. I know that many Americans think Asian students are a bit hard to communicate with or something like that. Recently the Asian hate this kind of stuff. And I don't really know all my classmates so I just feel a bit uncomfortable opening cameras* - IS1.

4.2.3   *Academic Performance.* We found that international students' grades in the class played a role in their decision to open or close cameras. Having high scores would boost their confidence and motivation to open their cameras and engage with classmates. Like- wise, if international students came to the class well-prepared, they were more likely to turn on cameras and contribute to class discussions. Conversely, four out of eight international students tended to close their cameras if they perceived themselves as not doing well academically:

> *When I know the quiz score, if the full score was 20, and the other people got 18 or 19, I only get 16 like this situation, my confidence minus a lot, so I will just say something on the chat box, not open the camera.* - IS3

On the other hand, domestic students did not associate camera use to the difficulty level of the class or their scores, unless opening cameras is required for attendance grades. Their motivation for opening cameras was more aligned with their interest in the class – as DS4 mentioned, *"in my favorite class, I think I got a B, but I opened cameras."*

4.2.4   *Classroom Expectation.* International students may not be familiar with classroom expectation in the US, which may be different from that in their home country. For instance,

teachers from China and Taiwan, among other Asian countries, tend to ask close-ended questions and expect students to know the answer [25]. In contrast, instructors in the US often act as facilitators who pose open-ended questions that may not have a designated answer. Due to this discrepancy, three interviewees mentioned closing the cameras as a means to help them avoid the instructor's attention, in case they are called on to answer a question which they don't know the answer for:

> *When the class is difficult, I did not open cameras because I am afraid the instructor will ask me to answer questions, and I experienced this when I took online classes in senior high school in China. I try to avoid opening cameras if I do not know the answer because I am really afraid the teacher will call me. - IS3*

4.2.5 *Objective Self-awareness.* According to the theory of objective self-awareness [18], when confronted with a stimulus, such as seeing oneself in a mirror, people's attention will be directed towards themselves, and they are more likely to enter a state of objective self-awareness [18, 23, 61], which will likely lead to self- evaluations [18]. In this scenario, people try to compare a salient aspect in themselves to an ideal representation of it, thereby becoming more self-critical [56]. This self-criticism could either lead to an avoidance of the state of self-awareness or modification to aspects of themselves to match the ideal self. In our interviews, two inter- national participants indicated that they tried to modify themselves to act in line with the classroom standards after seeing themselves in cameras. For example, they tried to pay full attention to classes, sit with straight back, and avoid making facial expressions in front of cameras.

> *I think when I turn on my camera I feel like I would be under the spotlight, and you know everybody's watching me, that's why I tend to sit straightly and try to avoid all the facial expressions, that's why I want to keep my camera off. - IS4*

A similar behavior was reported by domestic students; for in- stance, DS3 noted that:

> *I was hyper aware anytime like scratch my head or something like that. So pretty much from the start of [opening my camera], it was kind of distraction, because I was looking at myself, I'm kind of like self conscious so really right away after opening my camera, I was aware of my image. - DS3*

While the state of self-awareness emerged from students in both groups, we found that

international students tend to be more self- critical than domestic students due to their insecurity and anxiety, which may be attributed to other factors such as language barrier and feeling of minority. In this case, they were more likely to close their cameras to avoid entering the states of self-awareness and self-criticism. For example, IS1 mentioned that being a minority in class made her less willing to open cameras because she was afraid of being judged by people who held the belief that Asian students were shy and not good at communication.

5 DISCUSSION

In this work, we examined the reasoning behind students' lack of camera use when transitioning into synchronous online education [26], which poses difficulty to instructors who rely on non-verbal cues to evaluate and adjust their teachings. Our research is motivated by the need to identify solutions that both support instructors in online teaching and address students' concern with camera usage. Through a series of semi-structured interviews, we reported the most prominent factors that contributed to students' camera avoidance. Additionally, towards promoting inclusive interventions that accommodate different groups of learners, we investigated differences between domestic and international students' perception of camera usage, particularly with respect to its impact on their learning experience. In turn, we derive lessons for the design of online classrooms and learning platforms to support the continued transition into remote education.

5.1 Implication for Online Classes

5.1.1 Class characteristics and interactivity. Previous studies have reported the influence of class size on students' interactivity, which tends to increase in classes with fewer than 10 learners [45, 88]. Likewise, our research revealed that students based their camera usage decision on the perceived level of interactivity in the class, which was largely dependent on the class size. In large classes, most of the class time was occupied by the instructor's lecture, causing students to believe that their contribution was not necessary. In this case, students may choose to close their cameras, while being unaware that instructors do need to observe non-verbal cues from students to adjust their teachings [10]. On the other hand, small classes enable a more natural setting for students to participate and open their cameras as part of their interaction with instructors and classmates. In addition, the small class size allowed for a

wider variety of learning strategies that may improve students' active learning, group work and case studies.

Additionally, we found that students would close their cameras so as to not reveal themselves doing unrelated activities (e.g., taking a break) in long classes. These activities may interrupt the student's learning experience, causing them to miss crucial information covered in class; however, previous work has shown that students do tend to face difficulties in remaining attentive during long classes [45]. Therefore, accommodating to their need for occasional breaks could be helpful in both maintaining their attention and reducing their hesitance to open camera.

Based on these findings, we suggest the following lessons for instructors. First, instructors should let students know that opening their cameras allows for a better teaching experience, which would ultimately benefit the students themselves. Second, large classes should integrate time for group work and discussions, preferably in- between the topics covered in lectures, to reduce students' cognitive load and physical strain from prolonged screen time [60], while giving them a more active learning role, similar to that in small classes. These group activities may prompt students to express their opinion and feedback to the lecture topics [7], or simply self-explain what has been taught to their peers [16], as a means of reinforcing their learning.

5.1.2   *Breakout Rooms.* While students tend to close cameras in large classes but open cameras in small classes, we note that both behaviors are driven by the effect of conformity, i.e., the tendency to fit in with the majority. In this sense, breakout rooms serve as an excellent way to replicate the setting of a small class within a large class. Throughout our interviews we noted several instances of students showing willingness to open their cameras during break-out rooms, where they could see each other and interact directly and collaboratively. This positive effect of breakout room has been confirmed in several prior works (e.g., [12, 37, 66]); however, break- out rooms typically need structure and proper monitoring to be effective [43]. In small classes, the instructor could visit each room to join students' discussion and encourage them to speak up, while in large classes, teaching assistants may be utilized for this task [82]. An alternative approach is to create theme-based breakout rooms, each with a different discussion point and topic, allowing students the agency to move from one room to another to engage in multiple discussions [12].

5.1.3   *Alternative Virtual platforms.* While Zoom offers many functionalities for video-conferencing, we found that it cannot fully replicate the natural classroom atmosphere which students are used to. In a Zoom classroom, students cannot maintain eye contact with instructors and peers, nor are they aware of who is looking at them at the moment. Consequently, they may feel anxious about opening cameras and potentially exposing themselves to strangers, especially in large classes. To address this issue, we recommend that instructors consider a variety of online platforms to better facilitate personal presence. For example, while traditional lectures may be held via Zoom, class presentations could take place on Gather.town [1], which lets students control their own avatars and interact with each other in a 2D virtual world, simulating real-life interactions. Although students cannot exchange eye contact in this setting, they may obtain a more lively experience of walking around and talking with people. While a novel platform, Gather.town has been shown to be an effective learning space in several studies [40, 50] and may have powerful potentials in encouraging camera use.

5.2   Desensitize Camera Anxiety

Our interview data revealed that international students tend to develop heightened objective self-awareness [18] triggered by camera use, leading them to be more self-critical and hesitant about opening cameras than domestic students. In particular, we found that some international students experienced different degrees of stress, insecurity or anxiety originating from their language barriers, learning challenges or minority issues confronted in another country. To help students overcome the anxiety associated with camera use, one approach is to apply systematic desensitization, which has been shown to be effective in addressing situation-specific anxieties across diverse populations such as math anxiety [71], social anxiety [8] and speech anxiety [51]. For example, frequently exposing oneself to public speaking can desensitize the stimuli and help people gradually alter perceived negative thoughts about this activity [83]. Similarly, based on our study, we suggest that students who experience camera-related anxiety or stress practice opening cameras in relatively informal occasions, such as club meetings and group project meetings. Through exposing themselves to anxiety-arousing stimuli in these low-stake scenarios, students will gradually be able to reduce negative

1 https://www.gather.town/

feelings associated with camera use, which would help them become more comfortable with opening cameras in classes.

5.3 Digital Privacy

Two prominent aspects of privacy concern emerged during our interviews. First was the issue stemming from Zoom-bombing. During our interviews, a student reported being zoom-bombed which led him to close his camera in subsequent classes to avoid being recorded by strangers. While Zoom-bombing did not seem to be a common occurrence among our participants, the risk it posed was enough to warrant a lack of trust in the Zoom platform, causing many of the participants to close their cameras in classes. Second, students were cautious about showing their background, which may reveal personal information or capture other people sharing the space. While these issues have been mitigated over time thanks to new Zoom features, such as enabling password protection by default and allowing the use of virtual background, students may not know about and take advantage of them. Therefore, we recommend instructors to share privacy guidelines with students and show them the best practices in protecting their online identity. We expect that, once students feel more secure about their digital protection, they will also be more willing to open up.

5.4 Design Implications

5.4.1 Camera Technology Improvement. While cameras play an important role in video-conferencing software as a means of connecting participants, as previously discussed, they pose difficulties to users in making eye contacts with one another [13]. This limitation results in a lack of non-verbal cue that are needed for the exchange of information between instructors and students. As video-conferencing tools continue to serve millions of teachers and students during the pandemic, we encourage the integration of state-of-the-art camera technologies to enhance the learning experience. For instance, [77] utilized computer vision techniques to design a prototype that could track the position of the users' eyes in video-conferencing; by moving heads, users could control the cam- era position and manage their eye contacts. While this approach may raise further issues regarding privacy (e.g., which data does the video-conferencing tool require to enable this feature?) and accessibility (e.g., do students have sufficiently powerful machines to process computer vision models in real-time?),

its potential in transforming remote education does merit additional investigation.

5.4.2   *Discoverability of Zoom Features.* Discoverability refers to the degree of ease with which users can locate features or default settings within an application. Through our interviews, we found that students were unaware of several Zoom features which could be helpful in addressing their camera avoidance. For example, all participants in our interviews did not know about the "Hide Self View" feature, which prevents them from seeing themselves while opening cameras, thereby reducing their self-awareness and the resulting self-criticism. Other features such as auto-captioning could transcribe class conversations in real-time and help international students overcome the language barriers. We suggest that Zoom and other video-conferencing softwares make these features more prominent in their user interface design; at the same time, universities could host workshops and training sessions to raise awareness of such features in instructors and students.

5.5   Limitations and Future Work

Taken together, our findings helped uncover the underlying rea- sons for students' camera usage behavior in online classes. We also identified differences between domestic students and international students in their perspectives on opening cameras, while deriving actionable insights into addressing the reported issues. Nevertheless, there are certain limitations which may impact the interpretation of our results and shed light on future research directions.

First, as a result of our purposeful sampling, we only interviewed a small sample of students (13) from the same university. In addition, all of our international interviewees came from either China, Taiwan or Korea. While their experience with camera usage may be shared by many other international students, conducting similar interview studies on a more nationally and culturally diverse sample, for both the domestic group and international group, would likely yield important new insights not reported in this work. Second, while our international participants have only started their US education after high school, they may have different levels of prior exposure to the current learning style. For instance, students who attended international high schools in their home country would already undergo an English-based curriculum and may face less severe issues with language barriers than others. Towards promoting individualized intervention for supporting online learning, future research should further investigate how

international students' educational background may influence their learning experience.

Second, our study did not examine the potential influence of students' cultural backgrounds on their camera use. As cultural factors such as Islamic modesty and beliefs were reported to impact Islamic students' perspectives and behavior in online class settings [28], it would be important to examine this impact on a larger scale, with students from other cultures. To this end, Hofstede's five dimensions of culture [27] could be used as a holistic lens to characterize prominent cultural factors that may manifest in their online learning tendencies. For instance, a study by [31] reported that students from collectivism culture have different learning behaviors and participation in online classes than those from individualism culture; it is therefore conceivable that these two demographic groups differ in camera usage behavior as well.

In addition, our findings uncovered several differences between domestic students and international students which may be indicative of diverging academic perspectives. For example, international students based their decisions to open camera on how well they performed in the class, while domestic students on how much they liked the class. This difference may be due to a stronger emphasis on academic performance and pressure in Asian countries where our interviewees grew up in [44, 75, 79]; however, more rigorous research is needed to validate this conjecture and mitigate the risk of stereotyping.

Finally, rather than dichotomizing the interviewees' background into domestic and international students, future research could measure how students' learning experience and perception of cam- era usage change based on the amount of time they have spent in the US. This direction would likely lead to more granular insights into the influence of students' level of familiarity with the current educational system on their transition into online education.

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A   INTERVIEW CODEBOOK

Table 2: Codes for the commonalities between domestic and international students

Code label	Explanation	Count Example
Class size	The larger the class is, the more likely students would turn off cameras.	8/13 *"We had 300 people in the room. It is a huge class, I think I would turn off my camera. I mean there was nobody have [sic] their cameras on. I don't want to be the only one, because everybody is, you know, going to watch me."*- IS4
Class duration	The class duration influences students' camera use. The longer the class is, the less likely students would turn on cameras.	3/13 *"If the class was a really long class, I would probably turn my camera off, so I can do either work or, like any of those other things, because a three hour class, usually I could make a meal or something while paying attention."* - DS4
Class type	The type of class influences students' tendency to open or close cameras.	3/13 *"If there was a reason to have it on, I'd pretty much did have it on of course for tests and then I took a PE class which we were required to turn it on for exercise and stuffing. That was normal yeah."* - DS4
Class interactivity	The classroom dynamics influence students' camera use. Students' engagement in discussion will encourage others to open cameras.	3/13 *"I just feel like if someone engaged in discussions, it kinds of encouraged myself to do it as well. I don't think I will turn on camera if they just turn on the camera but didn't talk or something, that still makes me hesitant to turn on [camera] or engage in a conversation."* - IS8
Teaching mode	Classes including discussion components would more likely to trigger students' camera use.	5/13 *"When I discussed with, like talk to people, I just feel like I want to turn on the camera. So if the classes have a discussion, no matter which class, I will turn on my camera, but if it's just completely like looking through the powerpoints. I never turn on my camera."* - IS6
Privacy	Students' concern about privacy leakage would decrease their willingness to use cameras.	1/13 *"I won't open my cameras because I'm concerned about my data security. I have seen people joining the class and doing things like yelling or verbally attacking people. If I open camera, I try to have less things in the background or hide things that so that they don't tell much about my personal information."* - IS8

Table 3: Codes for the differences between domestic and international students

Code label	Explanation	Count Example
Language barriers	International students who have language barriers are more likely to close cameras.	3/13 *"It's stressful. I think this kind of anxiety from my language barrier will prevent me from opening my camera. I felt like I won't speak, because I am already nervous about it."* - IS6
Time zone differences	International students undergoing time zone differences are more likely to close cameras in midnights.	3/13 *"That was also the midnight in China, and I lay on my bed listening to my teachers talking. I'm so sleepy I really did not open my camera in the midnight."* - IS10
Minority	The perception of being the minority in a foreign classroom leads to international students' insecurity and hesitance to show themselves on camera.	4/13 *"Sometimes I feel a bit insecure because I'm Asian. I am not the majority of students in the class. So I feel a bit insecure. I know that many Americans think Asian students are a bit hard to communicate with or something like that. Recently the Asian hate this kind of stuff. And I don't really know all my classmates so I just feel a bit uncomfortable opening cameras."* - IS1
Academic performance	International students' grades in the class play a role in their decision to open or close cameras.	4/13 *"When I know the quiz score, if the full score was 20, and the other people got 18 or 19, I only get 16 like this situation, my confidence minus a lot, so I will just say something on the chat box, not open the camera."* - IS3
Classroom expectation	International students may not be familiar with classroom expectation in the US, resulting in their camera avoidance behavior.	3/13 *"When the class is difficult, I did not open cameras because I am afraid the instructor will ask me to answer questions, and I experienced this when I took online classes in senior high school in China. I try to avoid opening cameras if I do not know the answer because I am really afraid the teacher will call me."* - IS3
Self-appearance	Female international students are more likely to close cameras if they did not wear makeup.	5/13 *"Because I don't make up, yes, and anyone can look all the ulgy places of my face, so I did not open camera."* - IS8
Objective self-awareness	International students have heightened objective self-awareness, preferring closing cameras to stop objective self-awareness triggered by camera use.	4/13 *"I think when I turn on my camera I feel like I would be under the spotlight, and you know everybody's watching me, that's why I tend to sit straightly and try to avoid all the facial expressions, that's why I want to keep my camera off."* - IS4