"I Want to Reveal, but I Also Want to Hide" Understanding the Conflict of Revealing and Hiding Needs in Virtual Study Rooms

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Since the COVID-19 pandemic, video conferencing platforms have given rise to new virtual activities, such as virtual study rooms where users utilize video to share ambient presence for study motivation. In virtual study rooms, it can be challenging for the users to determine what to reveal and what to hide on camera, as the video needs to strongly convey their presence without revealing more than necessary. In this paper, we investigate the conflicting needs of virtual study room users to reveal and hide on camera, as well as the methods they employ to cope with these needs using videos. To this end, we conducted a three-step qualitative study. The first study involved interviews to discover the key user needs that entail the conflict to reveal and hide. The second study utilized virtual study room screen analysis to identify the video features that characterize virtual study room videos. In the last study, we employed interviews to associate the video features with the key user needs. Based on these findings, we discussed the effects of studying together that could be applied to a non-physical and non-interactive co-studying environment and the need for further development of video conferencing tools to effectively share ambient presence.

CCS Concepts: • **Human-centered computing → Collaborative and social computing → Empirical studies in collaborative and social computing**

Additional Key Words and Phrases: virtual study room; video conferencing; social presence; social learning; self-regulated learning; ambient presence; media space

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1 INTRODUCTION

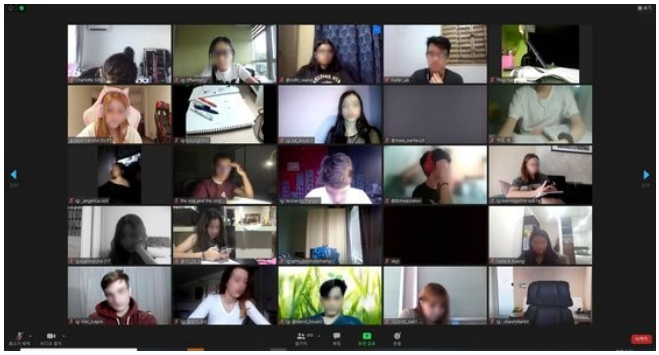

Fig. 1. A screenshot of an open virtual study room, 'StudyStream' [83]

COVID-19 gave rise to various virtual activities that use video conferencing platforms. People now gather, drink, watch movies, meditate and even exercise with each other through Zoom and Google Meet. These new activities include virtual study rooms, which are video conference rooms where people join to study in a library-like studying environment at home (Figure 1). In virtual study rooms, videos are used to share the ambient presence of a hard-studying individual while audio is often disabled to minimize any distractions. Virtual study rooms remain popular even after the pandemic with hundreds of concurrent users on virtual study room services like StudyVerse and StudyStream [83, 85].

In most other activities involving video conferences, users actively share information and interact with each other using video and audio. In these activities, the participants' presence is naturally shared in the interaction process. However, in virtual study rooms, users aim to maximize their presence while minimizing any unnecessary interactions using only videos. Hence, it may be difficult for the users to decide what to reveal and what to hide on camera, since the video should strongly deliver one's presence but at the same time deliver no more than the presence itself.

This paper aims to understand the virtual study room users' conflict of revealing and hiding needs and how they are coping with the conflicting needs through their videos. We conducted a three-step study, the first study to identify the key user needs, the second study to identify the video features of virtual study rooms, and the third study to understand how the video features are associated with the key needs.

In the first study, we conducted interviews with 31 participants about the perceived advantages and limitations of virtual study rooms. We then qualitatively analyzed the advantages and limitations to identify the key user needs. In the second study, we analyzed 464 actual virtual study room screens to identify the video features that characterize the videos. In the third study, we conducted interviews with 11 participants to understand how the video features are related to the key user needs. The participants were asked about their video feature preferences and underlying reasons and needs.

The results of the first study revealed the seven key needs of virtual study room users. Among them, strong presence, strong (self-)surveillance, high surveillance capacity, and stimulation of competitive spirit were related to users' revealing needs, and low self-awareness, low distraction, and protected privacy were related to users' hiding needs. As the result of the second study, we

identified the five major categories of video features that can help characterize virtual study room videos: main object, filter, the angle of the face, the visible part of the face, and whether the upper body and desk are in sight. The third study showed that three features (showing the front view of the face, showing the upper body, and showing the study material) were related to users' revealing needs, and four features (hiding the background, hiding the overall styling, not showing the full face, and not showing the full study material) were related to users' hiding needs.

After analyzing the results, we provide an in-depth discussion on the effectiveness of the activity and the usefulness of the tool. In terms of the activity, we could find that various theories regarding the impact of social factors on studying could be applied to virtual study rooms. This shows the effectiveness of studying in an environment where non-physical and non-interactive individuals' presence is felt. Looking at the tool, we compared virtual study rooms with previous studies on video conferencing for ambient presence and found that similar problems persist. While the current tool has partially implemented previous design strategies, the issues seem to remain unresolved.

This paper makes three key contributions: it (1) identifies the conflict between virtual study room users' revealing and hiding needs, (2) examines how users are utilizing video conferencing platform features to meet those needs, and (3) evaluates the effectiveness and usefulness of virtual study rooms from both an activity and tool standpoint by drawing connections to previous studies in the field.

2 RELATED WORKS

To gain a better understanding of virtual study rooms, we reviewed two different aspects of related works: (1) the impact of social factors on studying, and (2) the use of video conferencing for ambient presence.

2.1 Impact of Social Factors on Studying

The concepts related to the impact of social factors on studying include social presence, social learning, and self-regulated learning. These concepts are also related to Study with Me videos, which are similar to virtual study rooms in that they focus on sharing the presence of a studying individual using video.

2.1.1 Social Presence

Social presence was first defined by Short et al. in 1976 as "the degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships" in computer-mediated communication [82]. Short et al. explained that social presence is related to immediacy and intimacy, which are two characteristics of social interaction that can be influenced by the media [7, 58, 82]. While Short et al. had a technical-centered approach focusing on media, Gunawardena took a human-centered approach. Gunawardena defined social presence as "the degree to which a person is perceived as a 'real person' in mediated communication," focusing on how people perceive presence [41].

When social presence of other learners or instructors started to be emphasized in learning environments, researchers studying online learning conducted various studies on social presence from a human-centered approach [60, 75, 92]. Researchers have presented various theoretical frameworks for computer-mediated learning (CML) with social presence as the key element related to learners' satisfaction and achievement in the online learning environment [86, 93]. Researchers connected social presence to subjective factors like learner satisfaction [2, 42, 46, 54], perceived level of learning [76, 79, 87], self-evaluation of their own attitudes [80], learning motivation [17], and

encouragement [78], and objective factors such as actual performance [50, 75, 77], retention [10], and level of interaction in online classes [88].

Some researchers connected social presence in the learning environment with other concepts. For instance, Wang et al. explored the relationship between self-presentation behaviors and online learning presence [91]. Self-presentation refers to how people use techniques and methods to create their own impressions and make others form a specific view of themselves in interpersonal interactions. Here, their behaviors will usually tend to meet the wishes of others [39, 91]. Wang et al.'s study showed a high positive correlation between self-presentation and online learning presence, which consists of social and cognitive presence. In other words, how much you feel the presence of others is related to how much you put effort in presenting yourself to meet the expectation of others.

2.1.2 Social Learning

Social learning theory suggests that new behaviors can be acquired by observing and imitating others [4]. It proposes that learning is a cognitive process that takes place in a social context and can occur purely through observation [18]. Supporters of social learning theory focus on the benefits of joint participation in the learning process and emphasize the importance of building a learning community [15].

In the same vein, studies on study groups of students have shown that such groups have both educational and psychological benefits. From an educational perspective, students in study groups can ask and answer each other's questions about difficult or unfamiliar concepts, thus supplementing their knowledge [1, 45, 63]. They can also share study materials [1, 63], and teach each other new study methods [81]. Various discussions that occur in study groups were also found to be associated with better academic outcomes [59].

From a psychological perspective, study groups can provide emotional support and motivate learners by encouraging comparison with others. Study groups are typically composed of learners who study the same field or share the same goals. Through sharing experiences and emotions, learners can empathize and support each other, providing mental stability and emotional support [1, 45, 63, 81]. They can also compare their learning habits, effort, abilities, and results, which can help them identify their own shortcomings and increase their motivation to learn [45, 63]. Keren et al.'s work on gray literature on the effectiveness of study groups showed that even study groups that study separately without active social interaction can provide learning motivation [53].

2.1.3 Self-regulated Learning

Self-regulated learning (SRL) is an active and conscious process of self-regulating oneself cognitively, emotionally, and behaviorally to achieve their goal by planning, monitoring, and controlling their learning process [23, 57, 72, 95, 96]. Theories that emphasize the presence of others for effective self-regulated learning include social comparison theory and achievement goal theory.

Social comparison theory, initially proposed by Festinger, rests on the assumption that humans have an inherent need to evaluate their opinions and abilities, so when they lack objective means of comparison, they evaluate themselves through comparison to others [23, 34]. Here, the comparison tends to be made with others who are close to themselves but slightly better in terms of opinion and ability, so one will try to reduce discrepancies that exist between themselves and others [34]. Multiple studies have explored the usage of social comparison components as a feedback mechanism to support self-regulated learning in an online learning environment. In these studies, the social

comparison components were considered useful and effective [40, 74] and had a positive correlation with performance [22, 73], engagement [22, 40], and completion rate [23].

Achievement goal theory focuses on students' motivation in academic settings and explains how personal goals provide purpose, focus, and meaning to the activity [31, 64, 69]. Different types of achievement goals affect differently how individuals interpret achievement settings and decide achievement-related behaviors [27, 31]. The achievement goal framework produced by Elliot and colleagues distinguishes between the mastery-approach goal, which focuses on learning and developing skills, and the performance-approach goal, which focuses on accomplishing and outperforming other students [27-31]. Hence, students with performance goals are usually more sensitive to comparison [40].

2.1.4 Study with Me Videos

Study with Me (SWM) videos are recordings or live streams of oneself studying [49, 62, 90]. In video recordings, the creator focuses on studying without active motion or engagement with the camera, avoiding behaviors such as speaking or showing more than their natural studying behavior [62]. In live streams, the streamer refrains from interacting with viewers, such as by having rules not to respond to comments while streaming [90].

Previous studies on SWM videos examined the learning-related motivations and effects from both the viewers' [49, 62] and the streamers' perspectives [90]. Viewers found encouragement by comparing themselves to the hard-studying creator or streamer, gaining emotional support through companionship, and experiencing the social ambiance and presence of others as if they were studying together. Their non-social motivations included the ease of creating and controlling the environment, avoiding phone use during playback, and using the video as a ritual to switch into studying mode. For streamers, the presence of viewers acted as supervision of their studying behavior and provided emotional support and a sense of belonging.

Virtual study room users, though passively, engage socially with others by feeling each other's presence and possibly benefit from the social factors. However, limited research has been conducted on the specific effects and benefits of participating in virtual study rooms.

2.2 Use of Video Conferencing for Ambient Presence

The use of video conferencing for virtual study rooms is similar to media space in that the video is utilized to share presence and create a sense of being together.

2.2.1 Studies on Media Space

Media space refers to the use of audio, video, and computer networking technologies to extend physical space and connect remote groups, creating a sense of "being-in-place-together" [3, 6, 8, 24, 38]. Unlike other communication tools that are used for specific interactions, media spaces provide continuous video access for informal awareness of each other's presence and activities [6, 8, 9, 12, 25, 52].

Early media spaces, such as Media Space, Polyscope, NYNEX Portholes, CAVECAT, and RAVE, focused on connecting remote offices by linking personal desktops or common areas of the office [8, 9, 16, 20, 21, 24, 25, 35, 36, 48, 61, 65]. Studies then shifted to connecting remote workers operating from home [47, 66, 67]. More recent media spaces, such as Peek-A-Boo, Family Room, and Family Portals, aimed at linking remote family members [51, 52, 68, 70].

Although media space has numerous benefits, previous studies on media space highlighted several problems. The problems included privacy concerns [5, 12, 16, 19, 43, 44, 47, 48, 51, 52, 61, 65,

71], distraction and disturbance [5, 12, 19, 47], lack of shared presence [5, 61, 65], and excessive self-awareness [33, 61]. Privacy concerns arose because the users were unsure of who was watching their video and what they were seeing. Distraction and disturbance occurred because of unexpected and unwanted intrusions by others. Lack of shared presence was a bilateral problem where users could not adequately present themselves or perceive the presence of others, leading to less realistic interactions. Excessive self-awareness emerged as users became overly concerned about how they appeared on the video and became uncomfortable with the camera.

2.2.2 Revealing and Hiding in Media Space

The problems that occur when using media space could be conflicting, as some problems are solved by revealing more, and others by hiding more. Previous studies also pointed out that there is a trade-off between awareness and privacy or distraction, and that strategies are needed to adequately balance the tension between the two [6, 13, 36, 47, 94].

In response to the conflicting problems of media space, previous studies suggested various design strategies which could be grouped into strategies that reveal more information and strategies that hide information (Table 1).

Table 1. Design strategies of media space to reveal or hide information

Related Element	Strategies for Revealing More Information	Strategies for Hiding Information
Video	- Enabling access to previous recordings and frames [25, 47, 51, 52, 61, 68] - Providing activity timeline based on motion changes between frames [47, 51, 61] - Requiring video symmetry (I see you, you see me) [9, 16, 71] - Selecting and enlarging certain parts of others' videos [20, 21] - Providing a theater-like 3D view of multiple users' videos [47, 61] - Sharing multiple videos that are shoot from various angles [37]	- Sharing only captured video images [9, 16, 25, 61] - Blocking certain parts of my video (e.g. flare face, top blind) [20, 33, 51, 52, 68] - Video filter altering video clarity (e.g. blur, pixelization, sharpen) [11, 13, 21, 32, 33, 61, 66, 67, 94] - Video filter altering video brightness (e.g. darkening) [33, 61, 94] - Video filter altering image type (e.g. cartoonize) [33] - Video filter over parts with motion (e.g. edge-detection, shadow-view) [21, 33, 47, 94] - Video filter over background (e.g. blurred background) [33]
	- Controlling my video/image availability [5, 9, 13, 16, 20, 25, 26, 36, 61, 66, 67, 71] - Controlling my camera angle and view [20, 61, 66, 67]	
Audio	- Audio feedback that others are watching me [36]	- Audio filter reducing audio clarity [47]
	- Controlling my audio availability [20, 32, 66, 67]	
Additional Information	- Detecting if a certain user is present [20, 66, 67] - Information of who is watching or can watch me [5, 9, 61, 71] - Sharing information of my status and availability [19, 20, 26, 61]	

Virtual study rooms also face the issue of conflicting needs to reveal and hide, but the purpose of the activity is clearer and more specific, and they use new tools. Therefore, there is a need to investigate in-depth the specific needs of virtual study room users and how they are coping with those needs.

3 METHOD

To explore virtual study room users' conflict of revealing and hiding needs and how they are coping with the conflicting needs through their videos, we conducted a three-step study. The first study used interviews to identify the key user needs, the second study employed screen analysis of virtual study room videos to identify the video features, and the third study utilized interviews to understand how the video features are associated with the key needs.

3.1 First Study

To identify the key needs of virtual study room users, we conducted interviews with 31 participants about the advantages that motivate users to study and the limitations of virtual study rooms.

Interview participants were recruited through the online communities of various colleges, considering that virtual study rooms have been trending especially among students since the COVID-19 outbreak. We only recruited students who experienced studying alone at home when gatherings and use of public places were restricted due to the pandemic and then turned to virtual study rooms. A total of 31 participants who have experienced virtual study rooms participated in the interview. Among them, 13 were male and 18 were female, and ages ranged from 20 to 28 with a median age of 24. The demographic information of the interview participants is shown in Table 2.

Table 2. Demographic information of the interview participants

ID	Age	Gender	Occupation	ID	Age	Gender	Occupation
P01	20	Female	Undergraduate Student	P17	24	Female	Undergraduate Student
P02	20	Male	Undergraduate Student	P18	24	Female	Undergraduate Student
P03	20	Male	Undergraduate Student	P19	24	Female	Undergraduate Student
P04	21	Male	Undergraduate Student	P20	24	Female	Undergraduate Student
P05	21	Male	Undergraduate Student	P21	24	Female	Undergraduate Student
P06	21	Male	Undergraduate Student	P22	24	Female	Office Worker
P07	21	Male	Undergraduate Student	P23	24	Female	Undergraduate Student
P08	21	Male	Undergraduate Student	P24	24	Male	Undergraduate Student
P09	22	Male	Undergraduate Student	P25	25	Male	Job Seeker
P10	23	Female	Undergraduate Student	P26	26	Female	Office Worker
P11	23	Female	Undergraduate Student	P27	26	Male	Undergraduate Student
P12	23	Female	Undergraduate Student	P28	27	Female	Job Seeker
P13	23	Female	Undergraduate Student	P29	28	Male	Job Seeker
P14	24	Female	Undergraduate Student	P30	28	Female	Graduate Student
P15	24	Female	Graduate Student	P31	28	Male	Graduate Student
P16	24	Female	Undergraduate Student				

The interviews were conducted over the phone and lasted for 30 to 40 minutes. Participants were asked to describe their experiences of discovering and joining virtual study rooms, as well as the benefits of studying with others in a virtual setting compared to studying alone at home. They were also asked about any limitations of virtual study rooms that did not meet their expectations. All interviews were recorded with the consent of the participants and were transcribed for analysis. After the interview, the participants were compensated with a voucher worth 10,000 KRW (about 8 USD).

The interview data were analyzed by two researchers using thematic analysis for a comprehensive and flexible understanding [14]. Thematic analysis refers to an analysis method of finding conceptualized codes through analytical induction methods and identifying key themes by comparing and contrasting codes to find relationships and common messages between them [55]. To this end, open coding was performed, where we repeatedly merged concepts into groups based on relevancy and similarity [56]. Each researcher independently performed the first two steps of reading the interview results and running a low-level open coding. A High-level coding was conducted together involving discussions to resolve any conflicts.

3.2 Second Study

To identify the video features that characterize virtual study room videos, we analyzed 464 video screens captured from actual virtual study rooms.

We participated in eight virtual study rooms across three different virtual study room services: StudyStream, Study Together, and Virtual Study Room [83, 84, 89]. The study rooms featured gallery view layouts, displaying up to 49 videos per screen. Within an hour, we captured a screenshot of every screen in the eight study rooms, resulting in 13 screens. Next, we cropped the 13 screens into individual video screens, resulting in a total of 589 video screens. We then selected video screens that featured users who were actively studying. We excluded screens where the camera was off, the user was absent or lying on their desk, or the user was captured while moving. This left us with 464 video screens for analysis.

To analyze the video screens, we printed out all 464 screens and conducted a low-level coding of merging and splitting the video screens based on similarity. We then analyzed which features explained different groups of screens, focusing on those that were not affected by the users' movements, such as camera location and video effects. We used these features to define each video screen, and we continued to revise or create new features until every screen was explained.

3.3 Third Study

To understand how the video features are related to the key user needs, we conducted interviews with 11 participants asking what video features they prefer when participating in a virtual study room and why.

Interview participants of our second study were recruited through the online communities of various colleges. The participation criteria were limited to those who participated in virtual study rooms more than five times within the last six months. A total of 11 participants were recruited. Among them, five were male and six were female, and ages ranged from 20 to 25 with a median age of 22. The demographic information of the interview participants is shown in Table 3.

Table 3. Demographic information of the interview participants

ID	Age	Gender	Occupation	ID	Age	Gender	Occupation
P'01	20	Female	Undergraduate Student	P'07	22	Male	Undergraduate Student
P'02	20	Female	Undergraduate Student	P'08	23	Female	Undergraduate Student
P'03	21	Male	Undergraduate Student	P'09	23	Female	Undergraduate Student
P'04	21	Male	Undergraduate Student	P'10	23	Female	Undergraduate Student
P'05	21	Male	Undergraduate Student	P'11	25	Male	Undergraduate Student
P'06	22	Female	Undergraduate Student				

The Interview was conducted through video conference and lasted for about 20 minutes. To elicit the specific video features that the participants prefer, we used reproduced pictures of virtual study room video screens for the interview. We first showed and explained 14 different video screens to the participants through screen share. The participants were then asked to pick their preferred video screens. About their preferred screens, the participants were asked why they prefer or do not prefer a video screen with one's face, upper body, study materials, and filters. All interviews were audio-recorded with the consent of the participants and were transcribed for analysis. After the interview, the participants were compensated with a voucher worth 5,000 KRW (about 4 USD).

The interview data were analyzed by two researchers using the open coding method for thematic analysis. One researcher first repeatedly read the transcripts for familiarization and conducted iterative coding of merging, splitting, creating, and revising themes to reflect the entire data. Through this process, a codebook was created containing the sub-themes for the four major themes: 1) features related to revealing needs, 2) features related to hiding needs, 3) reasons behind the preference, and 4) related key user needs. Based on the codebook, two researchers independently conducted coding throughout the whole interview data. The results showed high inter-rater reliability with Cohen's kappa score of 0.79. The differences between the results were then resolved through discussions.

4 FINDINGS

As the result of the first study, we identified the seven key needs of virtual study room users. They were comprised of four needs that were related to users' revealing needs and three needs that were related to their hiding needs. The second study revealed the five major categories of video features that can characterize virtual study room videos. Through the third study, we associated the users' revealing needs with three video features and hiding needs with four video features.

4.1 First Study

The results of the first study revealed three advantages and six limitations of virtual study rooms. These advantages and limitations could be organized into seven key user needs comprising both revealing needs and hiding needs, implying a conflict between the users' revealing and hiding needs.

4.1.1 Advantages of Virtual Study Rooms

There were three advantages of virtual study rooms that motivated the users to study: 1) it delivers the presence of others, 2) it stimulates competitive spirit, and 3) it encourages self-surveillance. The presence of others was felt both physically and emotionally, the competitive spirit was stimulated

regarding both attitude and result, and self-surveillance was encouraged through both explicit and implicit agreements (Table 4).

Table 4. Advantages of virtual study rooms that motivate users to study

Advantages	Subcategories	Subcategory Details
Delivers the Presence of Others	Physical Presence	- Motivated to study by the physical presence of others
	Emotional Presence	- Motivated to study by the emotional presence of others
Stimulates Competitive Spirit	Regarding Attitude	- Motivated to study by comparing my studying behavior with that of others
	Regarding Result	- Motivated to study by trying to achieve better results than others
Encourages Self-surveillance	Through Explicit Agreement	- Motivated to study because of the explicit rules set within the group
	Through Implicit Agreement	- Motivated to study because of the implicit agreement to study hard

Feeling the physical presence of others could be done by either watching the video or just knowing that others are present. For instance, P28 answered, "I frequently looked at the videos when I was studying. For me, looking at how they study so hard was an important part of virtual study rooms," while P31 said, "I actually didn't look at the videos after joining the study room. What's important was that I know that they are there." Emotional presence provided users with the emotional support that made them feel like they are "not alone and with my friend (P20)" who could "work hard together (P29)." Similarly, P28 mentioned, "When I looked at the screen, I felt like there are people going through the same situation as me. This gave me a boost in motivating myself to study harder."

Competitive spirit regarding the studying attitude motivated users to study harder, as seen from P07's answer, "You know how you look at other people working really hard and you feel like you have to work even harder. It's like, he's doing the best he can, so I'm going to do the best I can, too." Competitive spirit regarding the result was especially stimulated when the users were studying the same subject as their study members. Regarding this, P08 said, "It's your friends and your colleagues, but they are also your competitors in tests. So we have this positive sense of competition. It's like, if I don't study now, I'm going to get left behind."

The explicit agreements that encouraged self-surveillance included rules and penalties. For some users, these rules were the strongest motivation, as seen from P11's answer, "The virtual study room that I joined had rules and we had to pay a fine if we didn't follow the rules. That was definitely most helpful because I didn't want to break the rules." In terms of keeping the implicit agreement to study hard, some users put emphasis on themselves while others put emphasis on other study members. For instance, P23, who focused on keeping the agreement for herself, said, "I studied hard to keep the promise that I made to myself. So if I didn't finish everything in time, I stayed and studied even when the studying time was over." On the other hand, P25 focused on others, saying, "I liked how it made me study because of how we gathered to study hard. It's like a promise, and they're not some strangers, so keeping the faith was important." For some users, this implicit agreement with others brought about a stronger self-surveillance effect when combined with a camera. P01 said, "I try to keep an upright posture at least for the part that is showing. When I'm leaning, it might seem like I'm not concentrating."

4.1.2 Limitations of Virtual Study Rooms

Virtual study rooms had six limitations: lack of presence, lack of surveillance, lack of surveillance capacity, excessive self-awareness, distraction, and lack of privacy (Table 5).

Table 5. Limitations of virtual study rooms

Limitations	Limitation Details
Lack of Presence	- Cannot feel enough presence of others
Lack of Surveillance	- Cannot be properly monitored by others
Lack of Surveillance Capacity	- Cannot properly monitor others
Excessive Self-awareness	- Become overly aware of how I appear on the video
Distraction	- Get distracted by others' videos
Lack of Privacy	- Cannot adequately protect privacy

Interview results showed that virtual study rooms may not provide enough presence compared to studying in real life. According to P24, "I often feel like there's a huge difference between meeting friends in person and meeting them online. I can see their face and hear them but it's not like we're actually together. The impact or influence that I get by studying together is much weaker because I can't feel the presence." P25 also said, "When you meet in person, you can really concentrate on studying, because it definitely feels like you're doing it together. Virtual study room, too, is a way of studying together but how much you feel like you're actually together is way different."

Surveillance for oneself was also lacking because of the cameras' blind spots. For instance, regarding the problem that one can slack off outside the camera, P20 said, "I sometimes played with my phone outside the camera and my friends didn't know about it. It was harder to concentrate because they couldn't see everything about me." P22 also confessed that she cheated sometimes, saying, "Frankly, you can pretend like you're studying if you want to. I did that too, sometimes, when I was really tired. No one knows that, so they can't stop me from doing that. And that's not good."

A similar limitation was raised in terms of monitoring others. In virtual study rooms, there seemed to be a lack of surveillance capacity to make sure that everyone is studying. Regarding the same example of slacking off outside the camera, P14 said, "I was kind of concerned because it doesn't feel like we're all studying if the camera doesn't show enough. What if she's playing games with her phone? At least show your hands." Lack of surveillance capacity was also mentioned when a study member works with a laptop and uses the same laptop to join the virtual study room. P03 explained, "They use the same laptop to join Zoom and to study. And they sometimes watch YouTube and I can't really tell because I only see their face."

Participants also pointed out that virtual study rooms may lead to excessive self-awareness. People seemed to be overly aware of how they appear on the video as seen from P15's answer, "I was kind of concerned about how I appear on the video. Say, I just did something weird unconsciously. What if they saw it? Is my face weird right now? Did they all see it?" P23 explained that the fact that they can see their face adds to this problem, saying, "My facial expressions and everything are captured every second and I'm looking right at it. It was kind of uncomfortable."

Distraction by others' videos was also mentioned as a limitation. P04 said, "Sometimes when you look at others' videos, it's distracting. People can change their posture while studying, or at least they move their hands, but even that can distract you too." One participant explained that this was especially the case when the other is doing activities that can draw your attention. According to

P19, "My friend was very distracting when I studied with her. She would put her dog on her lap, she would bite her nails… And when she does that, I keep looking at it. That was very distracting."

Lastly, participants were concerned about the lack of privacy in virtual study rooms. P26 was concerned about her room, saying, "I couldn't use the background filter because of some problem with my laptop. I wanted to hide my room but I couldn't." P15 talked about her experience with the bathroom, saying, "I had to go to the bathroom, and I was like, should I tell them? I really wanted to go. But I don't want them to know how long I spent in the bathroom."

4.1.3 Key Needs of Virtual Study Room Users

Based on the aforementioned advantages and limitations, we identified the seven key needs of virtual study room users: strong presence, strong (self-)surveillance, high surveillance capacity, stimulation of competitive spirit, low self-awareness, low distraction, and protected privacy.

Given that virtual study rooms primarily rely on video rather than audio, meeting these needs may depend on how users choose to present themselves on camera. While strong presence, strong (self-)surveillance, high surveillance capacity, and stimulation of competitive spirit could be met by revealing more, low self-awareness, low distraction, and protected privacy could be met by hiding more. Therefore, there was a conflict between the revealing needs and the hiding needs for a successful virtual study room experience (Figure 2).

Fig. 2. Conflict of revealing and hiding needs among the seven key needs of virtual study room users

4.2 Second Study

Through the second study, we could identify the five major categories of video features that can help characterize virtual study room videos.

The five major categories of features were 1) main object, 2) filter, 3) the angle of the face (among person view), 4) the visible part of the face (among person view), and 5) whether the upper body and desk are in sight (among person view). The number of video screens for each feature is shown in Figure 3.

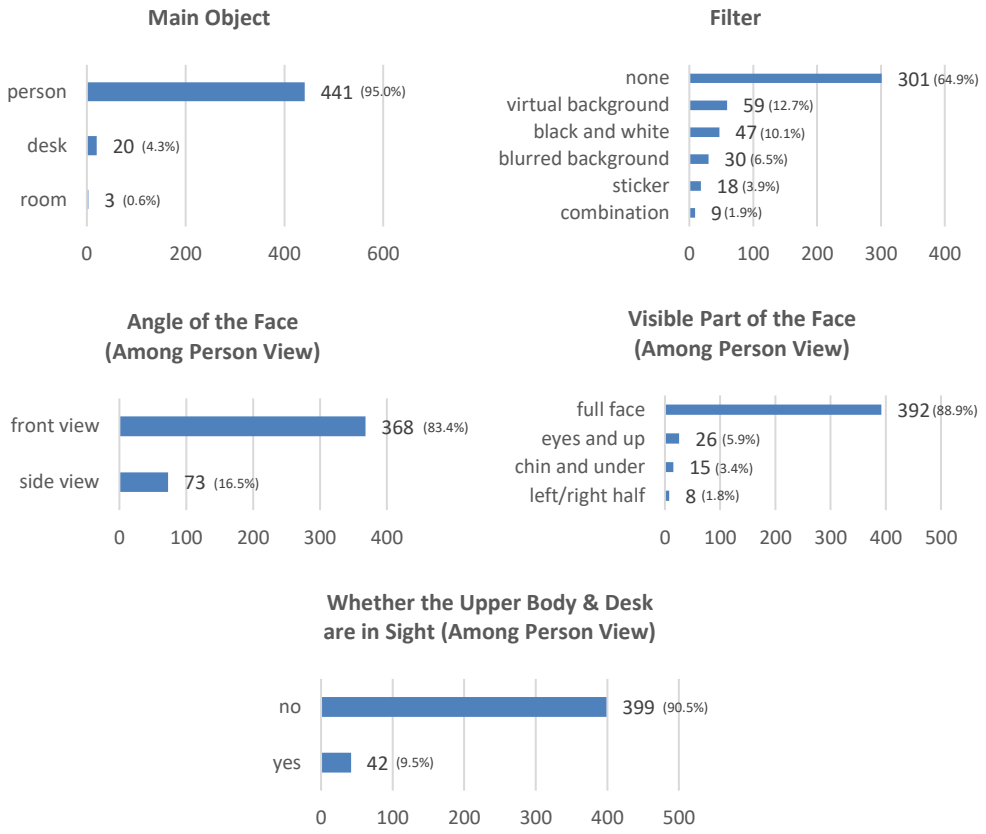

Fig. 3. A summary of 464 video screens by the features

The main object of the video was categorized into person, desk, and room. The person view is when the camera is facing the user as in usual video conferences. The desk view is an aerial shot of the desk, usually done by placing the camera higher than one's desk and shooting it from above. The room view is an aerial shot of the whole room, similar to the view of security cameras. Among them, person view was the most common with 441 screens out of 464 screens.

For the filters, there were virtual background, blurred background, black and white, sticker, and a combination of two or more. The virtual and blurred background only alters the background of the user, the black and white filter applies to the entire video, and the sticker is used to cover certain parts of the user's face. For instance, a sunglass sticker covers the user's eyes, a face mask sticker covers the user's nose and mouth, and a hat sticker covers the user's hairstyle. All nine cases of using multiple filters combined blurred or virtual background with a sticker. Video screens that use no filter at all were the most common with 301 screens. Among the screens with filters, the virtual background was most used with 59 screens out of 104 screens.

For person view videos, three additional features could be identified: the angle of the face, the visible part of the face, and whether the upper body and desk are in sight. The angle of the face could be categorized into a front view and a side view. The front view was more common than the side view with 368 screens. The visible part of the face was categorized into full face, eyes and up, chin and under, and left or right half. Among them, video screens that show the full face were the

most common with 392 screens. Whether the upper body and desk are in sight determined whether the screen provides a wider view of how the user is studying. 399 screens did not provide this view, showing only the shoulders and up. In the other 42 screens that showed the upper body and desk, we could see the users turning pages and writing notes on their study materials.

4.3 Third Study

The third study showed that three video features were related to users' revealing needs and four video features were related to users' hiding needs.

4.3.1 Video Features and Revealing Needs

According to the interview results, the following three video features were associated with users' revealing needs among the seven key needs of virtual study room users: showing the front view of the face, showing the upper body, and showing the study material (Table 6).

Table 6. Features related to revealing needs, reasons behind the preference, and related revealing needs

Features	Reasons Behind the Preference	Related Revealing Needs
Showing the Front View of the Face	- To feel like I am facing and studying together with my friend	Strong Presence
	- To feel like someone is watching and monitoring me	Strong Presence Strong (Self-)surveillance
	- To prove that I am studying through facial expressions and gaze directions	Strong (Self-)surveillance
	- To check if others are studying by watching their facial expressions and gaze directions	High Surveillance Capacity
Showing the Upper Body	- To increase the general atmosphere and presence of people studying	Strong Presence
	- To feel like I am studying together with my friend	Strong Presence
	- To prove that I am studying through my posture and arm movements	Strong (Self-)surveillance
	- To check if others are studying by watching their posture and arm movements	High Surveillance Capacity
Showing the Study Material	- To prove that I am studying by showing how I work with my study materials	Strong (Self-)surveillance
	- To check if others are studying by watching how they work with their study materials	High Surveillance Capacity
	- To compare each other's work and stimulate competitive spirit	Stimulation of Competitive Spirit

Four out of 11 participants (P'01, P'04, P'05, P'08) felt that the front view of the face can increase each other's presence by allowing them to face each other while studying. P'04 said, "If you see the whole face from the front, it feels like you're studying together." One participant emphasized that it should be the front and not the side of the face, saying, "If I can't see their face, it's the same as Study with Me videos. What I need from a virtual study room is a sense of being together. That's why I want to see their face, and it has to be the front face because the side view makes you feel like you're not facing each other. (P'01)"

One participant (P'07) said that the front view of the face also provides a feeling of someone watching and monitoring you, which is related to both presence and (self-)surveillance. According to P'07, "When the front face is showing, I feel like the person is watching me, and that adds to the surveillance effect."

Seven participants (P'01, P'02, P'03, P'04, P'05, P'06, P'11) answered that the front view of the face can be a great source to prove and check if someone is studying. Some participants even claimed that subtle changes in facial expressions and gaze directions are better proof than the upper body, desk, and study materials. According to P'02, "You can see if you're concentrating, spacing out, or doing something else if you look at the face." P'03 especially stressed gaze directions, saying, it "proves how much you are absorbed in studying." P'05 and P'06 emphasized how the front view of the face can clearly show if you are drowsing or not. P'04 emphasized that showing the full face is important, saying, "If you only show a part of your face, it's less obvious if you're concentrating or not."

Three participants (P'02, P'03, P'04) mentioned how the upper body can provide a greater studying presence. According to the participants, a wider view of people studying can effectively deliver a studying presence and create a studying atmosphere. P'02 answered, "I prefer seeing my friend writing notes and stuff. It gives you a better sense that she's there, studying hard."

According to two participants (P'02, P'05), showing the upper body can also provide a sense of being together. P'05 said, "I usually sit across from my friend at libraries when we study together. So seeing the whole upper body and desk feels more like we're studying together."

Three participants (P'02, P'03, P'05) said that the upper body can prove that one is studying by showing their posture and arm movements. P'02 answered, "To prove that I'm studying, the face, the upper body, and my arm should all be on the video. Showing your arms is important. The movement of the arms naturally shows that you're studying as you write notes and hold the materials."

Study materials were also mentioned as a good way to prove and check if one is studying according to three participants (P'04, P'05, P'07). The surveillance effect of showing one's study materials comes from the fact that one can clearly show what they are doing. P'07, who chose the desk view as one of his favorite screens, said, "For me, it's important that I prove that I'm holding a pen and not a phone. And this video can clearly show my books and my hands and what I'm doing with them."

Lastly, two participants (P'05, P'11) mentioned that the competitive spirit can be stimulated if one reveals his or her study materials. P'11 added that this effect can become "greater if you're preparing for the same test because you can see what materials they are studying with."

4.3.2 Video Features and Hiding Needs

The interview results showed that the following four video features were associated with users' hiding needs among the seven key user needs: hiding the background, hiding the overall styling, not showing the full face, and not showing the full study material (Table 7).

Table 7. Features related to hiding needs, reasons behind the preference, and related hiding needs

Features	Reasons Behind the Preference	Related Hiding Needs
Hiding the Background	- To resolve the burden of caring about how my living space appears on the video	Low Self-awareness
	- To protect the privacy of my living space	Protected Privacy
	- To minimize unnecessary attention to the background	Low Distraction
Hiding the Overall Styling	- To not care about what to wear and how I look	Low Self-awareness
Not Showing the Full Face	- To resolve the burden of showing my whole face	Low Self-awareness
Not Showing the Full Study Material	- To minimize the possibility of distracting others	Low Distraction

Two out of 11 participants (P'01, P'07) cared about how their living space appeared on the video and wanted to hide their background. P'07 explained that this is less of a privacy problem and more of a cleaning problem, saying, "I use a virtual or blurred background when my room is dirty and I don't want them to see it." P'01 was concerned about the tidiness of her bed, saying, "My bed is behind my desk, so I hide my background when I don't want others to see my bed."

Four participants (P'06, P'08, P'09, P'10) mentioned the protection of privacy as the reason for hiding their background. P'10 answered, "It's important for me that my living space is not exposed as much as possible. I don't want people to see my room, so I usually use blurred background." P'06 added that protecting privacy is especially important "when you're studying with strangers."

Hiding the background was also a way to minimize any unnecessary attention on the background according to two participants (P'03, P'05). P'05 explained that he prefers the virtual or blurred background filter that can "hide things other than your body" because "if the video is too colorful and it catches your eye, it can distract people from studying." P'03 claimed that "It's best to use the background filters because I want people to focus on me studying when they see my video."

Two participants (P'02, P'09) wanted to hide their overall styling to not care about what to wear and how they look when they study. P'02 said, "I'm usually a bit scruffy when I'm studying, so I prefer placing the camera a bit far away from me." P'09 wanted to hide her overall styling while revealing her face, so she used "background filters because it kind of hides your body and your clothes, but it doesn't hide your face and the facial expressions."

Three participants (P'03, P'08, P'10) were uncomfortable with revealing their whole faces. Among them, P'03 and P'08 were experiencing a conflict between revealing and hiding needs. They preferred revealing their front view of the face for study motivations, but they were also uncomfortable with showing their whole face. P'03, who emphasized the importance of revealing the gaze directions, resolved this conflict by showing only the left or right half of his face. He said, "Showing the whole face is a bit burdensome. But showing only half of your face can minimize this burden while showing your gaze directions." P'08 resolved this conflict by showing only her eyes and up, saying, "I think showing the upper part of the face can still give you a sense of studying together while not being that uncomfortable."

Showing the entire study material was considered a distraction by one participant (P'04). P'04 said, "If you show the entire study material and what you're working on, it can distract others." He was experiencing a conflict between revealing and hiding needs because he also wanted to reveal

his study materials for self-surveillance. He resolved this conflict by choosing to "show only a part of" his study materials.

4.4 Summary

Through our three-step study, we identified the seven key needs of virtual study room users that showed a conflict between revealing needs (strong presence, strong (self-)surveillance, high surveillance capacity, and stimulation of competitive spirit) and hiding needs (low self-awareness, low distraction, and protected privacy). We found that five key categories of video features could characterize virtual study room videos and that users were utilizing various features to meet their conflicting needs. Specifically, showing the front view of the face, showing the upper body, and showing the study material could help fulfill users' revealing needs, and hiding the background, hiding the overall styling, not showing the full face, and not showing the full study material could help satisfy users' hiding needs.

5 DISCUSSIONS

Our findings on the advantages of virtual study rooms suggest that users are benefiting from the social effects of studying together. However, we also found that there are limitations to using video conferencing as a tool to share ambient presence. In this section, we connect our study with previous research on two key topics: (1) the social effects of studying together and (2) the use of video conferencing as a tool to share ambient presence.

5.1 Social Effects of Studying Together

Virtual study rooms passively apply social factors to the learning environment by adding the mere presence of others through computational media, without requiring active interaction or changing the physical environment. This makes them an ideal setting to investigate the social effects of studying together without active or physical interaction. In this section, we discuss the social effects of a non-physical and non-interactive co-studying environment by connecting the advantages of virtual study rooms (delivering presence, stimulating competitive spirit, and encouraging self-surveillance) with the concepts that explain the impact of social factors on studying.

5.1.1 Delivering Physical and Emotional Presence: Social Presence and Social Learning

Virtual study rooms can deliver social presence and foster social learning. The participants of the first study explained that virtual study rooms encouraged them to study harder since they felt "like I have a friend studying with me (P20)." Although social presence in computer-mediated learning often involves active interaction occurring through the exchange of information and opinions [86, 93], virtual study rooms allowed participants to perceive each other as "real people" even without such interaction.

Furthermore, virtual study rooms offer a source of mental stability and emotional support, comparable to study groups. However, unlike study groups that achieve this through sharing feelings and experiences [1, 45], virtual study room users feel a sense of shared experience and emotional support simply by seeing others. Participants recognized that they are not alone in their struggles, as P31 remarked, "I could see that I was not the only one going through this." P27 also shared the sentiment, "When I see their tired and exhausted eyes, I feel a strong sense of empathy. It's like we're both experiencing similar hardships, and that somehow gives me strength."

5.1.2 *Stimulating Competitive Spirit: Social Learning, Social Comparison, and Achievement Goal*

Virtual study rooms can stimulate competitive spirit through the mere presence of others, by making users compare themselves to others similar to social learning theory, social comparison theory, and achievement goal theory. The difference is that previous studies showed users comparing more specific information, such as time spent on studying, depth of knowledge, current progress, test answers, and scores [22, 23, 30, 40, 45, 63, 73, 74], but virtual study room users only compare a fragmented view of each other studying. More specifically, users were comparing the degree of effort implied by each other's simple studying appearances, as seen in P09's response, "You can see that other students are studying hard, so I should study harder" and P05's response, "When I see them studying hard, I feel like I should work harder than them". Here, they inferred others' level of effort based on their studying appearances and showed a willingness to work harder. When the users are in the same group studying the same subject, they also seem to infer the performance of others just based on their appearances and compare it with their own expected performance. For instance, P08 said, "It's your friends...but they are also your competitors in tests.... If I don't study now, I'm going to get left behind."

5.1.3 *Encouraging Self-surveillance: Self-presentation*

The presence of other people in virtual study rooms encouraged users to pay attention to how they were presenting themselves, which promoted self-surveillance. While this self-presentation theory applied to both virtual study rooms and online learning environments, there were differences in what users focused on to improve their self-presentation. In the previous study, self-presentation influenced how students interacted with each other, such as their enthusiasm for posting, willingness to ask questions, and willingness to reply and share [91]. However, virtual study room users paid attention to whether they were presented on camera as hard-studying individuals. For example, P28 said, "I kept looking at the screen to check if my hardworking appearance is being captured well… I thought other friends would be checking me out, just like I was checking them out. I felt like I should show them I was working hard, so I wondered if that was captured well." This is also reflected in P01's response, "I try to keep an upright posture... When I'm leaning, it might seem like I'm not concentrating."

5.1.4 *Study with Me and Virtual Study Room*

Study with Me videos, similar to virtual study rooms, provide the mere presence of another person through computational media without active interaction or change of the physical environment. However, there is a notable difference between the two activities. While virtual study rooms enable a reciprocal share of information, SWM videos predominantly deliver information unilaterally from the streamer to the viewer. As a result, the viewers of SWM videos and the users of virtual study rooms both watch how others study, but only the users of virtual study rooms actively share their own studying behavior.

The act of observing and receiving information about another individual's studying session generates similar study motivations in both activities. When comparing how SWM videos and virtual study rooms motivate users to study, our research and previous studies on SWM videos both highlighted delivering physical presence (feeling the ambient presence), delivering emotional presence (gaining emotional support), and stimulating competitive spirit regarding attitude (comparing their studying attitude).

On the other hand, the distinction of whether the users share their own information reveals contrasting user behaviors and helps identify specific shortcomings in each activity. SWM videos may lack the ability to stimulate a competitive spirit regarding outcomes and self-surveillance

through explicit and implicit agreements, which are enhanced when users actively disclose their own information. In contrast, users of virtual study rooms may experience excessive self-awareness, distractions, and a lack of privacy due to their self-disclosure.

5.2 Video Conferencing as a Tool to Share Ambient Presence

Both media spaces and virtual study rooms use video conferencing to share ambient presence. By connecting our study with previous works, we can discover which design strategies suggested for media space were actually applied to today's video conferencing tools. Additionally, comparing the problems between the two tools allows us to determine whether the applied strategies solved these problems. This section compares video strategies and problems of media space and virtual study rooms. For the strategies, we focus on those that address the users' hiding needs, as we want to focus on the tool and we believe that the tool's characteristics are more closely related to users' hiding needs.

5.2.1 Video Strategies of Media Space and Virtual Study Rooms

As we organized in 2.2.2, previous studies on media space suggested various design strategies for revealing and hiding information through video, audio, and additional channels. Interestingly, the type of hiding strategies for the video of media space coincides with most of the video features used in virtual study rooms. Both media space and virtual study rooms utilize controlling video availability, controlling the angle and view of the camera, using a filter on the entire video, using a filter on the background, and concealing certain parts of the video, while only media space employed turning the video into a static form (Table 9).

Table 9. Hiding strategies for the video of media space and virtual study rooms

Hiding Strategies for the Video	Media Space	Virtual Study Room
Controlling Availability	- Controlling my video/image availability	- Turning the camera on/off
Controlling Angle and View	- Controlling my camera angle and view	- Controlling camera angle and view
Using Filter on Entire Video	- Video filter altering video clarity - Video filter altering video brightness - Video filter altering image type	- Black and white filter
Using Filter on Background	- Video filter over background	- Virtual background - Blurred background
Concealing Certain Parts	- Blocking certain parts of my video - Video filter over parts with motion	- Sticker
Turning into Static Form	- Sharing only captured video images	(None)

5.2.2 Problems of Media Space and Virtual Study Rooms

Problems of media space include privacy concerns, distraction and disturbance, lack of shared presence, and excessive self-awareness (2.2.1). Our study found that virtual study rooms also have similar limitations, such as 'lack of privacy', 'distraction', 'lack of presence', and 'excessive self-awareness'. Two limitations that only arise in virtual study rooms are 'lack of surveillance' and 'lack of surveillance capacity'. These are virtual study room-specific problems that rise from the activity's core purpose to increase study motivation, which makes surveillance so critical.

While several video strategies suggested in previous studies on media space have been applied to the new video conferencing tool used in virtual study rooms, the repeated problems with the tool suggest that additional strategies are needed to use video conferencing as an effective tool to share ambient presence.

5.3 Limitations and Future Work

We have identified three limitations of this study that may hinder a complete understanding of the social effects of studying together in virtual study rooms. Firstly, we only compared the advantages and limitations of virtual study rooms with that of studying alone at home, without considering other co-studying experiences. Secondly, we did not take into account the influence of relationships with other study room members, which could be crucial in shaping the social experience of studying together. Lastly, we only examined the users' preferences for their own videos, without acknowledging that conflict can also arise between features preferred in one's own videos and others' videos.

Possible future research could involve a more comprehensive investigation of virtual study room users' experiences in comparison to other co-studying experiences, such as studying at a library or using SWM videos, to identify virtual study room-specific characteristics. Additionally, exploring the impact of participants' relationships, such as whether they are close friends or strangers, would offer further insights into this activity. Finally, understanding the conflict between the users' preferences for their own videos and others' videos would provide a clearer understanding of users' needs when creating an ambient presence through video conferencing, and offer guidance for designing appropriate tools.

6 CONCLUSION

This study aimed to explore the conflicting needs of virtual study room users to reveal and hide on camera and how they are coping with these conflicting needs through their videos. We conducted a three-step qualitative study, including interviews and screen analysis. The results of the study showed that users have seven key needs that include both revealing needs (strong presence, self-surveillance, high surveillance capacity, and stimulation of competitive spirit) and hiding needs (low self-awareness, low distraction, and protected privacy). In addition, we identified five major categories of video features that can be used to characterize virtual study room videos, including the main object, filter, angle of the face, visible part of the face, and whether the upper body and desk are in sight. We found that three features (showing the front view of the face, showing the upper body, and showing the study material) could help meet users' revealing needs, while four features (hiding the background, hiding the overall styling, not showing the full face, and not showing the full study material) could help meet users' hiding needs. Finally, we discussed the social effects of studying together that can be identified in virtual study rooms and the usefulness of video conferencing as a tool to share ambient presence.

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APPENDIX

After conducting the interviews in the first study, we conducted a survey to gain insights into general virtual studying patterns, covering the 4W and 1H aspects (who, when, where, why, how). The survey was distributed through the online communities of various colleges, with participation criteria limited to individuals who participated in virtual study rooms more than five times within the last six months. A total of 107 users participated in the survey, including 28 males and 79 females, with ages ranging from 20 to 34 and a median age of 23. After the survey, the participants were compensated with a voucher worth 3,000 KRW (about 2.5 USD).

Table A1. Survey questions

Category	Survey Questions
Who	- Who did you study with? - How many people did you study with?
When	- What time of the day did you study? - How long did you study?
Where	- Where did you study?
Why	- Why did you participate?
How	- What device did you use? - Was the camera on or off? - Was the microphone on or off?

Survey results showed that users usually join virtual study rooms with three to four friends after school or work for two to three hours at home to study hard. They mostly used laptops with cameras on and microphones off.

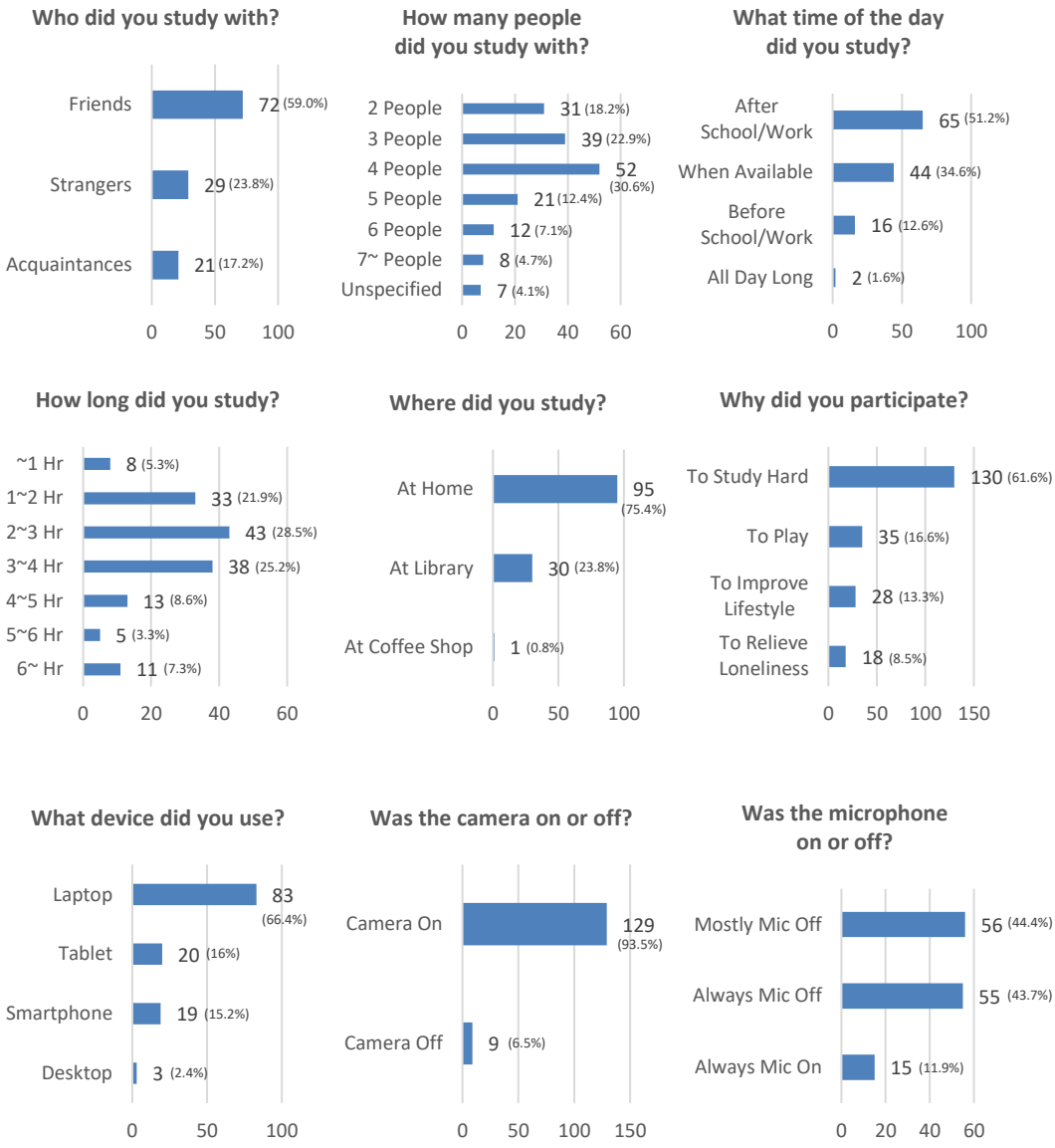

Fig. A1. A summary of answers to survey questions

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