"Generation invisible?. Higher Education Students' (Non)Use of Webcams in Synchronous Online Learning

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ABSTRACT

The pandemic situation continues to influence teaching and learning in higher education, with students oftentimes participating in synchronous videoconferencing sessions as a means to interact with peers and instructors. The frequently noted non-use of webcams by students incited the current study, investigating usage behavior as well as potentially related course variables and individual characteristics. $N = 3,527$ students from a German university took part in an online survey at the end of the regular summer term 2020 (August 2020). Findings indicate that students' webcam usage behavior was related to personal thoughts and feelings (e.g., privacy), to course characteristics (e.g., group cohesion), and it differed due to specific groups (gender, study level). With the ongoing importance of videoconferencing in higher education, this study provides a foundation for further investigation into this synchronous learning context.

1. Introduction

On a global scale, higher education has turned to emergency remote teaching (Hodges et al., 2020) as an institutional response to the outbreak of the COVID-19 pandemic in 2020. To provide synchronous interaction and learning activities as part of their online teaching repertoire, educators used a range of videoconferencing tools (Al-Samarraie, 2019; Correia, Liu, & Xu, 2020), leading to an unprecedented surge of international reliance on this particular form of digital interaction (Bonk, 2020). It would appear that students overwhelmingly disagreed with the assumed outcome that making oneself visible and able to see others would enhance the feeling of group membership and thus would be perceived as an easy means to foster social presence (e.g. Lowenthal & Snelson, 2017). This was initially indicated by (informal) explorations over the course of the summer term 2020 (April to July) that looked into why students usually refrain from using their webcams during videoconferencing sessions (Eng, 2020; Loviscach, 2020).

The current study delves further into this topic and investigates this frequently perceived phenomenon from the student perspective. Upon the provision of empirical evidence, we aim to contribute to this emerging discussion rooted in instructors' and students' currently lived experience in higher education teaching and learning. One impact of the COVID-19 pandemic might be a further reliance on both synchronous and asynchronous online learning as an integral part of higher education. Hence, the present study investigates this currently observed phenomenon of students' (non)use of webcams via the responses of an $N=$ 3,527 student sample at a large German university. It aims to shed light on the student perspective in so far as webcam use is concerned; how course-related factors are related to webcam use; and how frequency of webcam use is related to student characteristics. It asks educators to cautiously keep in mind the various reasons students employ in an effort to remain "invisible" in class and provides a foundation from which to conduct further research on this topic.

2. Theoretical Lenses and Literature Review

In the context of (online) distance education, concepts such as the Community of Inquiry model (CoI; Garrison et al., 1999; Garrison, 2007) and the theory of transactional distance (Moore, 1991, 1993) provide important lenses for understanding the social dynamics evolving within the distance teaching and learning setting. Next to addressing cognitive and teaching presence, the CoI model encompasses social presence, meaning "the ability of participants in the Community of Inquiry to project their personal characteristics into the community,

thereby presenting themselves to the other participants as 'real people'" (Garrison et al., 1999, p. 89). Social presence has evolved into a well-researched—albeit still hard to grasp—topic (e.g. Kreijns et al., 2021; Lowenthal & Snelson, 2017; Mykota, 2017; Öztok & Kehrwald, 2017), encompassing a diversification of definitions and understandings. For example, Kreijns et al. (2021) now consider social presence to be one part of the broader concept of *social interaction*, alongside *sociability* and *social space*; while keeping social presence as the component that makes participants seem 'real' (n. p.). Still, establishing this sense of group belonging and interacting with other learners are important ingredients for students' achievement and overall engagement in online learning scenarios (Joksimović et al., 2015; Tomas et al., 2015). As part of social presence (e.g. Lowenthal & Snelson, 2017), students need the feeling of belonging—which can be a challenge in an online learning setting, considering that it might be difficult for students to both create and perceive social presence (Joksimović et al., 2015).

The theory of transactional distance (Moore, 1993) emphasizes the geographical separation between students and instructor in distance education settings and in doing so, adds to our understanding of the complexity of communication. The theory argues that this distance causes a "psychological and communications gap" (Moore, 1991, p. 2), within which "a space of potential misunderstanding between the inputs of instructor and those of the learner" (p. 2) exists. Moore's (1993) theory revolves around the three concepts of structure of the course, the dialogue between learner and instructor, and the autonomy of the learner.

The use of videoconferencing tools—specifically the use of webcams—is likely a means through which direct interaction and dialogue within an online course can flourish (Al Samarraie, 2019; Giesbers et al., 2013; Gillies, 2008; Lenkaitis, 2020). However, as Lawson et al. (2010) recapitulate in their review on the use of videoconferencing in schools and in higher education, previous research highlights different aspects related to its use, indicating that results are mixed.

Several studies highlight positive aspects related to the use of videoconferencing within educational and professional settings. The study by Giesbers et al. (2013) showed that for their sample ($N = 110$ students) in a fully online preparatory course for prospective business students at a Dutch university, regular participation in videoconferences and the use of richer and accessible tools within said videoconference (i.e. chat, video, audio) resulted in higher participation and subsequently, in better student test performance. Likewise evaluated from the perspective of learners, Turkish pre-service teachers studying English viewed videoconferencing positively for the purposes of following a presentation held by a guest speaker abroad (Candarli & Yuksel, 2012).

Focusing on the use of webcams as part of the videoconferencing setting, Olson et al. (2012) found that for virtual teams—in this case, faculty members collaborating remotely on research projects—enjoyment, connection to the group and trust increased over time as did the focus on the meeting itself. For their sample of higher education administrators, Lowden and Hostetter (2012) reported high levels of satisfaction when using videoconferencing for professional meetings within higher education administration. However, one participant also noted the problem of keeping mutual eye-contact via webcam. Using webcams in student-to-student dyadic foreign language practice emerged as crucial for the creation of informal and credible communication; with some study participants also reporting that seeing themselves on video also worked as control function in regard to their non-verbal communication (Telles, 2010). The study on 56 teacher education students by Nilsen et al. (2013) likewise shows mixed results as students reported increased awareness of posture and conduct since "broadcasting with your own web camera also makes you feel more visible" (p. 97). Nonetheless, students did feel more comfortable with their webcams turned off. For the specific situation of instructor-adult learners, dyadic videoconferencing sessions for English language learning purposes, Kozar (2016) showed that the pairs—who all had at least 150 hours previous experiences with online learning and were at least 24

years old—tended to use their webcam mostly in the first lessons to create rapport. The use then declined, with instructors using their webcam more frequently than students did. Webcams were perceived as helpful in the beginning sessions but students also saw them as tiring, uncomfortable and intrusive. Develotte et al. (2010) likewise stressed that social aspects of relationships are aided by webcam use: "Webcamming creates presence at a distance, installs an obvious connection between the participants and, furthermore, develops the quality of the pedagogical relationship [...]" (p. 309). However, they equally conceded that at times their study participants chose to not use the webcam to more closely concentrate on the audio elements.

One participant in Wunder's (2017) qualitative study, an instructor, deliberately refrained from using a webcam to avoid stereotyping on her person; another reported only using the webcam in the beginning and end of a session as he or she did not find it "that important" (p. 117). However, Codreanu and Combe Celik (2013) showed that the tutors can, through their framing of gestures, mimicry, and eye contact when using a webcam in videoconferencing, set the scene for how much students feel included in the learning situation and how they mirror the tutors' behavior. For the teaching presence of an instructor in videoconferencing sessions, Rehn et al. (2016) concluded that the pedagogy needs to be adapted to this specific context.

This relates to the finding in the study by Nilsen et al. (2013), where students also raised the point that in a lecture situation that does not foster active student involvement, there appeared to be no reason to turn on their webcam. The authors summarize that, "Allowing your face to be viewed via a web camera implies a completely different awareness of the learning situation, and renders you more mentally present than if you sit in an auditorium looking at the back of a fellow student in front of you" (p. 101).

Within the present context of the Covid-19 pandemic, videoconferencing has emerged as one of the predominantly used technologies within higher education as found in a systematic review encompassing 282 studies (Bond, Bedenlier, Marín, & Händel, 2021) , with all the caution that is appropriate in regard to its pedagogical potential in this specific situation (Rapanta et al., 2020). With videoconferencing exceeding the mere educational context by far, the phenomenon of "zoom fatigue" (Bailenson, 2021) has garnered attention, complemented by a first exploration into the different perception of female and male voices in videoconferencing (Siegert & Niebuhr, 2021). Finally, the study on $N = 276$ students of biological sciences by Castelli and Sarvary (2021) reported on the (non)use of webcams across numerous sections of one biology course in spring 2020. Based on the responses to an end of course survey, the authors showed that 90% of students chose to turn off their webcams at least for a certain amount of time during the videoconference sessions. Being concerned about one's appearance was indicated as a reason to do so by 41% of participants; amongst other reasons, it was "it was the norm" (to not use the webcam) that 52.8% students stated. Based on data collected from $N = 407$ students at a Romanian university from December 2020 to January 2021, Gherheş et al. (2021) presented similar results, for example with 19.4% students stating that it was anxiety/fear of being exposed/shame/shyness (p. 6) that kept them from turning on their webcam. However, the course norm of not using the webcam was only indicated by 11.3% of students as a reason to not use theirs. What emerges from the literature is that a set of different reasons exists for students to use or not use a webcam, ranging from questions related to a perceived invasion of privacy as indicated in Kozar (2016); levels of shyness (Gherheş et al., 2021); or a simple lack of perceived reason for webcam use (Nilsen et al., 2013). Evidently, however, student usage patterns in terms of actual frequency of use have yet to be comprehensively investigated. The same applies to the educational setting in which webcams are being employed. The research that was conducted into this topic prior to the Covid-19 pandemic focussed partly on the context of language learning (e.g. Develotte et al., 2010; Lenkaitis, 2020), on rather specific contexts of dyadic conversation (e.g. Kozar, 2016; Telles, 2010), or on one discipline (Nilsen et al., 2013) -

with these studies relying on overall small sample sizes and employing mostly qualitative approaches. With the Covid-19 pandemic resulting in increased reliance on videoconferencing and institution-wide application, research into this topic has taken to target webcam (non)use (Castelli & Sarvary, 2021; Gherheş et al., 2021). The current study deepens and extends the knowledge in this area through its investigation of a larger sample of students, sourced from different disciplines and applying validated scales alongside self-developed and context-specific items.

3. Research Questions

Due to the Covid-19 pandemic, students across all fields of study participated in online courses, oftentimes including synchronous videoconferencing sessions. To better understand students' videoconferencing behavior in higher education courses and to investigate potential concepts related to webcam use, the current study investigated four main research questions.

First, the study aimed to provide a quantitative base through which to display students' webcam using frequency (Q1). It secondly focused on students' perceptions when using webcams in higher education courses (Q2). Third, with reference to the CoI, the study investigated whether using webcams in online higher education courses was related to how students perceived their courses as far as peer and student-teacher relationships were concerned (Q3). Finally, to provide a comprehensive overview on webcam use, the study investigated whether webcam use differed due to individual characteristics (gender, field of study, study level, or migration background; Q4). In detail, the studies research questions were:

- Q1: How frequently do higher education students use their webcam in videoconferencing sessions?
- Q2: How do higher education students perceive webcam use and do their perceptions differ with regard to their usage frequency?
- Q3: How are course-related characteristics (i.e. group cohesion, communication, lecturer-student relationships) related to students' webcam use?
- Q4: What student characteristics are related to the frequency of webcam use?

4. Method

4.1. Procedure

The current research inquiry is part of a longitudinal study, conducted as an online survey with three measurements. Directly before, during, and after the summer term 2020, all students enrolled at one German university were invited via email to participate in an online survey. Students were informed that the topic was online learning and that participation took approximately 20 minutes. The online survey was carried out in the German language and administered via Unipark Questback EFS (https://ww2.unipark.de/). In accordance with the institutional commissioner for data protection, the privacy of study participants' remained guarded, all data was anonymized, and students were not disadvantaged due to non-participation. Informed consent of the participants was obtained by virtue of survey completion. In the following, we focus on the third assessment at the end of the term (August 2020) when all courses were finished and students could report on experiences made.

4.2. Sample

Participating students were recruited from one large German university with a student body of about 38,500. The third measurement of the online survey in August 2020, to which we are referring in this study, was completed by 3,527 students. In addition, data on migration background was available from an earlier measurement (with $n = 1,578$ students participating in both assessments). Students' mean age was 23.6

years ($SD = 4.7$). Gender distribution and further student characteristics are depicted in Table 1. Students participated in the survey across all five faculties[1] of the university. Similarly, students from different levels of study participated in the online survey.

4.3. Instruments

All items were presented in the German language. As depicted in Table 1, students were firstly asked to provide information on their socio-economic and study-related characteristics. To assess whether students feel competent with online communication, we assessed their self-reported skills relevant to sharing information online (subscale information sharing behavior of the questionnaire on digital readiness for academic engagement – DRAE, Hong & Kim, 2018). The four item scale was internally consistent (Cronbach's $\alpha = .84$, sample item "I can interact with classmates using real-time communication tools, for example, video conferencing tools or messengers").

Webcam use and accordant perceptions were assessed via five newly developed and self-constructed items. Webcam use was assessed via one item ("How often do you use the webcam in webinars?"). Students could answer the question on a five-point answer scale: never (1), seldom (2), sometimes (3), often (4), or always (5). Students were then asked what they think about and how they feel using a webcam via four items. All individual items of the questionnaire scales described below were answered on a six-point Likert scale with the following answer options: strongly disagree; disagree; rather disagree; rather agree; agree; strongly agree. Students rated their technical equipment for participating in online discussions: "My technical equipment was not sufficient (e.g. webcam or internet quality; participation only via smartphone)". Regarding privacy, we implemented the following item: "It bothered me that others can see into my privacy (e.g. room furnishings, possibly other people in the room)". We asked students how they feel when using a webcam: "I was uncomfortable being connected via webcam (e.g. shyness; unfamiliarity with seeing my own picture; unsuitable outfit)". Finally, we assessed their usage behavior with regard to conformity aspects: "I adapted my webcam use to the community (e.g. only turned it on when most of my fellow students have done so)".

Teacher-student relationship was assessed via an established three item scale (Kauper et al. 2012; sample item: "The lecturers were friendly and respectful towards me", $\alpha = .89$). Furthermore, two subscales of the CoI were used to assess social presence (Díaz, et al., 2010). Each three items were used to assess group cohesion (sample item: "I felt that my point of view was acknowledged by other course participants", $\alpha = .73$) and openness of communication (sample item: "I felt comfortable conversing through the online medium", $\alpha = .86$).

4.4. Data Analysis

To answer research questions Q1 (frequency of webcam use), Q2 (perceptions of webcam use), and Q3 (relationships of webcam use and course-related characteristics), we performed descriptive and correlative analyses. As a rule of thumb, correlations are considered small for Spearman's rho ≥ .10, medium for rho ≥ .30, and large for rho ≥ .50 (Field, 2018). To understand whether there are groups of students showing characteristic webcam use (Q4), we performed separate univariate analyses of (co)variance. Gender, degree of study, and migration background were used as independent variables and webcam use as the dependent variable. To study differences with regard to faculty affiliation, gender was used as a covariate due to well-known gender differences for the enrollment in specific study subjects like engineering or arts. As gender, belonging faculty, study program, or migration background was not available for the full sample (cf., Table 1), sample sizes slightly differ for the analyses. Partial eta squared was reported as a measure of

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[1] A German "faculty" is comparable to a "college" or "school" in the international academic context.

Table 1

Characteristics of Participating Students (Absolute Number and Percentage)

Variable	Absolute number of students	Percentage of students
Gender		
Female	1,922	54.5
Male	518	31.2
Non-binary	10	0.3
Not indicated	493	14.0
Migration background (born outside Germany; non-German native language, data available from *n* = 1,578 students)		
Yes	152	9.6
No	1,426	90.4
Not indicated	0	0.0
Belonging faculty		
Faculty of Humanities, Social Sciences, and Theology	952	27.0
Faculty of Sciences	482	13.7
Faculty of Business, Economics, and Law	721	20.4
Faculty of Engineering	866	24.6
Faculty of Medicine	495	14.0
Not indicated	11	0.3
Studied program		
Bachelor	1,302	36.1
Master	962	27.2
State exam	1,095	31.2
Doctoral exam	75	2.1
Others	32	1.4
Not indicated	45	1.3

Table 2

Descriptive Statistics (*M, SD*) and Correlation Results (Spearmans' rho) of all Variables Under Consideration

	M (SD)	Having technical problems	Having privacy concerns	Feeling un-comfortable	Use in compliance with others	Teacher-student interaction	Open communication	Group cohesion
Webcam use	2.65 (1.22)	−.14***	−.36***	−.42***	.06***	.18***	.21***	.22**
Having technical problems	2.47 (1.53)		.16***	.14***	−.05**	−.18***	−.14***	−.15***
Having privacy concerns	3.51 (1.58)			.60***	−.01	−.21***	−.29***	−.28***
Feeling uncomfortable	3.56 (1.59)				.09***	−.21***	−.39***	−.34***
Use in compliance with others	4.30 (1.59)					.04*	−.04*	−.02
Teacher-student interaction	5.00 (0.81)						.35***	.36***
Open communication	3.95 (1.05)							.80***
Group cohesion	3.84 (0.97)							−

Note. All variables range from 1 to 6, except for webcam use (1–5). * *p* < .05. ** *p* < .01. *** *p* < .001.

effect sizes. According to Cohen (1973), effects are considered small for $\eta^2 \geq .01$, medium for $\eta^2 \geq .06$, and large for $\eta^2 \geq .14$. All analyses were performed using SPSS, version 26.

5. Results

Students in the current sample seemed to feel quite competent in communicating and sharing information online (*M* = 5.30, *SD* = 0.82). Table 2 provides descriptive statistics and correlations of all variables of the current study. Teacher-student interaction was rated high, while open communication and group cohesion were lower but still above scale mean average.

5.1. Webcam Use and Accordant Perceptions

Regarding webcam use (that is, research question Q1), students scored at the scale mean, which corresponds to using the webcam in synchronous online courses "seldom[ly]" to "sometimes". While about 22% of students indicated foregoing webcam use altogether, only about 7% of students used it always. The other 71% of students varied in their webcam use from seldom to often (compare Figure 1).

Furthermore, Table 2 reports descriptive statistics regarding student experiences with webcam use (Q2). Descriptively comparing mean values, students' technical equipment for participate in online courses via webcam seemed acceptable (low value regarding technical problems).
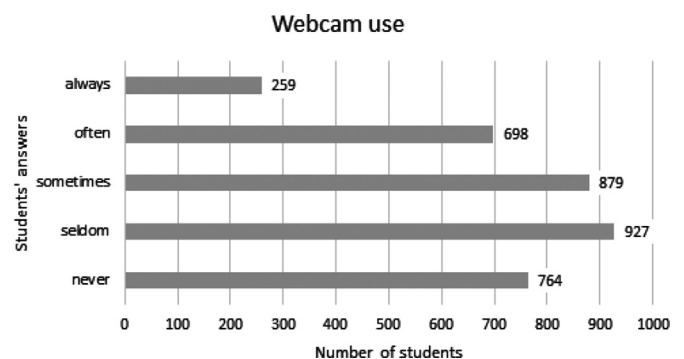

Figure 1. Number of students using webcams to a varying degree.

To an average degree, students were bothered that other course participants had insight into their private sphere. Similarly, on average, students were not very comfortable presenting themselves online. Students provided relatively high values regarding webcam use in compliance with others. Correlations within the set of variables assessing student perceptions of webcam use indicate that the assessed aspects of webcam use measured separate aspects (with the exception of having privacy concerns and feeling uncomfortable, which were strongly related to each other). In addition, we were interested in whether the
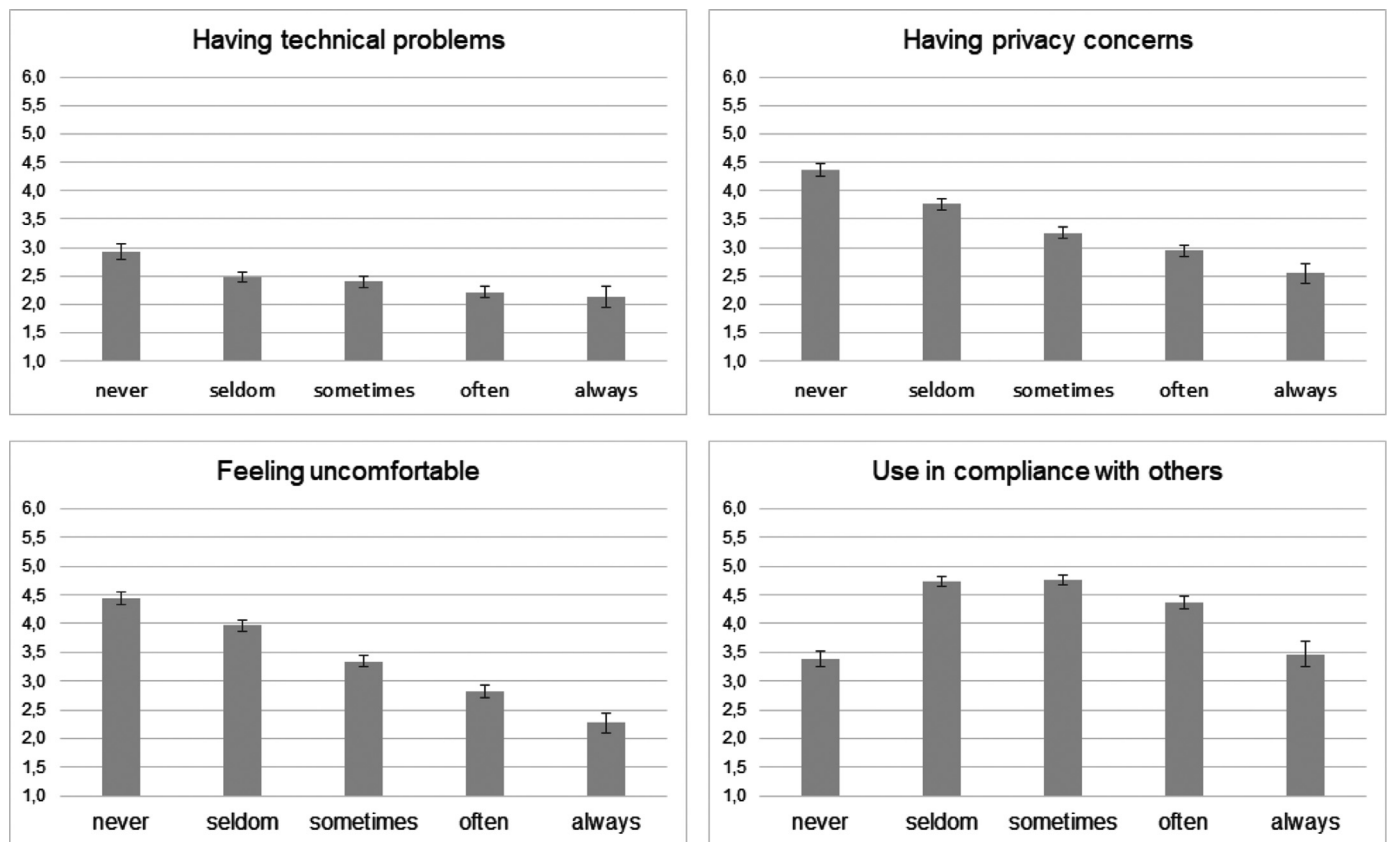
Figure 2. Students' perceptions of webcam use, separately displayed for students of varying webcam use. Error bars indicate 95% confidence intervals.

frequency of webcam use was related to the perceptions emerging from it (Q2). Correlational analyses in Table 2 indicate small (technical problems, compliance) and moderate correlations (privacy concerns, feeling uncomfortable). To better understand these correlations, Figure 2 illustrates perceptions for each frequency of webcam use. It shows how having technical problems, privacy concerns, and feeling uncomfortable related to frequency of webcam use. Namely, students with less frequent use reported higher concerns or problems. A different distribution is shown for whether the webcam was used in compliance with peers. The two groups of students who either *never* or *always* used webcams in synchronous online courses, did not relate their choice of using the webcam or not as much in compliance with their peers' behavior compared to those students who showed varying personal webcam usage behavior (seldom, sometimes, or oftentimes). This non-linear usage behavior might explain the low correlation.

5.2. Webcam Use and Relationship with Course-Related Characteristics

To understand how course-related characteristics (i.e. teacher-student relationship, communication, and group cohesion) are related to webcam use (Q3), we considered the correlations displayed in Table 2. Results indicate that webcam use itself positively correlated with experiences during a course of online learning. That is, students who experienced a good teacher-student interaction, that they could communicate openly, and that group cohesion was high, used their webcam more often (small correlations). Additional privacy concerns or feelings of discomfort were reported by students whose relationship with their teacher was relatively worse and by those who reported less open communication and less group cohesion. Experiencing technical problems and complying with others in webcam use weakly (or even non-significantly) related to teacher-student relationship, open communication, or group cohesion.

Table 3

Descriptive Statistics (M, SD) of Webcam Use [Ranging from 1—never to 5—always] for Students Enrolled in Study Programs at Different Faculties

Faculty	*M*	*SD*
Humanities, Social Sciences, and Theology	3.38	1.16
Sciences	2.46	1.16
Business, Economics, and Law	2.50	1.16
Engineering	2.06	1.03
Medicine	2.80	1.09

5.3. Group Differences in Webcam Use

Analyses of (co)variance results are presented to understand whether students differed in their webcam use with regard to gender, faculty, degree of study, or migration background (Q4).

First, the ANOVA with gender as independent variable revealed a significant but small effect, $F(1, 3022) = 50.70$, $p < .001$, $\eta^2 = .02$. Female students reported webcam use for synchronous online communication more often ($M = 2.80$, $SD = 1.22$) than male students did ($M = 2.46$, $SD = 1.21$).

When investigating differences between students enrolled in different faculties, we controlled for gender as a covariate (especially as students of different genders are more often enrolled, for example, in humanities programs than in engineering study programs). The ANCOVA found a significant and large effect, $F(4, 3012) = 133.07$, $p < .001$, $\eta^2 = .15$. Descriptive values in Table 3 indicate that students of the Faculty of Humanities, Social Sciences, and Theology reported most frequent webcam use in synchronous online communication (between sometimes and often) while engineering students made use of webcams in synchronous online communication only seldom.

To investigate whether students of varying levels of study differed in webcam use, we restricted our analysis to students on the two study levels of Bachelor and Master programs. This decision was made in order to formally comply with and relate to the broader international distinction

of study levels and to have ascertained information that students have already obtained a first degree (Masters) and have thus previous higher education experience. The latter would be rather difficult to discern for teacher education students and students of medicine enrolled in state programs in Germany. With doctoral students normally not being enrolled in regular classes in the German system, this group was neither considered . The ANOVA with study program as independent variable found a significant but small effect, indicating that students of a Master's program ($n = 962$, $M = 2.68$, $SD = 1.24$) used their webcam slightly more often than students of a Bachelor's program ($n = 1302$, $M = 2.42$, $SD = 1.20$; $F(1, 2262) = 25.98$, $p < .001$, $\eta^2 = .01$).

Finally, no significant effect with regard to migration background was found, $F(1, 1576) = 0.68$, $p = .41$.

6. Discussion

The present study surveyed student behavior as it relates to webcam use in a large sample of students sourced from one university. Overall, higher education students in the current sample felt ready to share information online; that is, they seemed to be able to interact in synchronous learning, which seems important for students' socio-emotional perceptions as well as their help-seeking behavior (Händel et al., 2020)(Naujoks et al., 2021). Still, it found that a remarkable amount of students indeed remained invisible in online higher education in the summer term 2020 (Q1). An explanation for absent webcam use might be that the audio part in online synchronous course sessions ("webinars") was sufficient while the video part served rather as an enrichment not necessary for understanding (see Olson et al., 2012). However, online communication that is enhanced by video is also considered helpful to emotionally establish the grounds for ensuing pedagogical interaction (Gillies, 2008); showing that online course communication follows different patterns than it does during in-person instruction. However, the choice to refrain from webcam use potentially reduces students' means altogether for developing a social presence in an academic course or during web conferencing sessions (Develotte et al., 2010). Actually, the frequency of webcam use was only weakly related to technical issues but moderately related to privacy concerns and personal feelings, thus confirming prior research on the matter (Q2; Kozar, 2016; Castelli & Sarvary, 2021). Therefore, instructors might consider their own webcam use behavior. For example, educators should avoid bookending webcam use (only using it at the beginning and end of a session) as was the case with one instructor in Wunder's (2017) study. Instead, openly addressing this topic (Eng, 2020), and integrating small activities to foster webcam use are better means that instructors can employ. Furthermore, instructors can actively work toward more webcam use by simply letting their students see them, thereby setting an example after which students can model their behavior.

Further results indicated that webcam use and experiences emerging from it were significantly related to the perception of course characteristics (Q3). Nilsen et al. (2013) found that students did not use their webcam because they felt more comfortable without it or the session did not require an active part on their behalf. Still, the results reported here support open communication and the fostering of personal or closer relationships, both of which are vital for establishing social presence (Garrison et al., 1999; Lowenthal & Snelson, 2017).

The study identified groups of students with varying webcam use (Q4). In detail, female students, students of humanities, and Master program students reported to having used their webcam in synchronous online communication more often than male students, students of other faculties, or Bachelor program students. An explanation for the differences between Bachelor and Master students might be that students who are familiar with higher education itself may be more willing to engage in online study with the appropriate tools. Hence, regarding upcoming digital or hybrid semesters, first year students may find online synchronous course sessions via videoconferencing particularly challenging. Cultural differences, however, do not seem to play a major role as

migration background was not meaningfully related to webcam use (at least for this sample of a German university). When referring to webcam use in synchronous online communication, it should be noted that this study is concerned with self-reported use across all synchronous online courses that include the option to use webcams. In other words, when referring to differences in webcam use between faculties or study degree, this research does not include a claim that specific academic courses captured herein offer more or less online courses than any other study programs. Quite the contrary, it means that across all courses, students reported webcam use to a varying degree. Moore (1991) stresses that a specific program or course structure can rarely accommodate the needs of all learners or learning types alike, which might also be applicable to subgroups in this study.

7. Limitations

The current paper relies on a broad student sample from across a variety of study subjects and course types. However, due to its comprehensive investigation of webcam use, the study did not control for specific characteristics of synchronous courses (i.e., course size, level of student activation via, for example, teacher-student or student-student interactions, giving presentations etc.; see Nilsen et al., 2013). In addition, webcam use was assessed via self-report, and we did not track students' actual usage times. Hence, student reports might be influenced by their personal interpretation of what "seldom," "sometimes," or "often" mean (in contrast to "never" and "always,"). Similarly, results might be limited in comparison to results from other international studies as they stem from a German student population with items translated from English to German and with partly modified answer options (for reasons of consistency, we mostly used 6-point Likert scales). For future research, we suggest to assess webcam use more precisely, for example, via situation-specific approaches (i.e., course-, lesson-, or situation-specific) to divide in which learning situations (e.g., collaborative tasks vs. listening to a talk) students make use of their webcam and why.

In addition, we did not control for potential teacher influences and hence, those self-reports might be further biased. Some lecturers might have emphasized webcam use in particular, while others might not have done so, potentially altering student perceptions of webcam use. Moreover, our study design does not inform about causal relationships. That is, regarding course characteristics, it might be that group cohesion was lower due to fewer students using webcams or that students used their webcams less often because they experienced low group cohesion. Finally, as this study was established in reaction to the sudden shift to online learning, no established questionnaire scales on student perceptions of webcam use had been available. Hence, the study assessed student perception via single items only and might not have comprehensively displayed all facets of student webcam usage.

8. Conclusion

The relationship between webcam use and feelings of discomfort points to differences between in-person course settings (where students are by definition present) and online course settings. It is possible that students might feel uncomfortable because they cannot see or *feel* who looks at them or because they can see themselves, an unusual characteristic not present in in-person communication. This is suggested in the video-chat study by Miller et al. (2017). They conclude that, "participants were more concerned about how others perceive them when they could see themselves" (p. 5278). Hence, the current results might promote the development of videoconferencing settings that make digital communication as natural as possible, aligning with Castelli and Sarvary (2021) who suggest employing teaching strategies that encourage participation. Another feature of digital communication captured in this study concerns peer-to-peer relationships. Students may perceive less social support and therefore be less willing to engage in social relationships. Thus, instructors and student support services might consider ad-

ditional intervention strategies since key findings underscore the importance of social support and engagement for learning success (Hsu et al., 2018).

Although it was not within its scope, the "space of potential misunderstanding between the inputs of instructor and those of the learner" (Moore, 1991, pp. 2) due to the physical separation of learners and instructors and the mediation of webcams is exemplified in this study—with students having distinct reasons for not using their camera. The latter student rationale is typically unknown to the instructor, leaving room for possible misinterpretation. To avoid misinterpretation and to potentially foster dialogue on how communication occurs in a specific course, jointly establishing a code of conduct in regards to webcam (non)use might be a way to tackle this situation.

Henceforth, to derive meaningful conclusions for future educational practice, there is a need for research that describes webcam use in different educational course settings, investigates its potential outcomes, and combines student and instructor perspectives.

Declaration of Interest

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ijedro.2021.100068.

Appendix 1

Table 4
Item Text in German and English language

Scale	Item text in German language (as implemented in the Study)	Item text in English language
Digital Readiness for Academic Engagement (subscale information sharing behavior; ISB; Hong & Kim, 2018; DRAE)	Ich kann mit Kommilitonen/-innen mittels Echtzeit-Kommunikationsmedien, z. B. Videokonferenztools oder Messenger-Diensten, interagieren.	I can interact with classmates using real-time communication tools, for example, video conferencing tools or messengers.
	Ich kann meine Meinungen im Internet teilen, z. B. über Blogs, soziale Medien oder Webseiten.	I can share my opinions online, for example, with blogs, social networking services, or web pages.
	Ich kann Dateien mit meinen Kommilitonen/-innen mittels Internetanwendungen (Cloud-Software) teilen.	I can share my files with classmates using online software.
	Ich kann mit meinen Kommilitonen/-innen via Internetanwendungen zusammenarbeiten.	I can collaborate with classmates using online software.
Webcam use	Wie häufig nutzten Sie die Webcam-Funktion in Lehrveranstaltungen mit interaktiven Elementen wie Online-Diskussionen inkl. Webcamzuschaltung?	How often do you use the webcam in courses that enable interaction between the participants including webcam use?
Having technical problems	Meine technische Ausstattung war nicht ausreichend (z.B. Webcam- oder Internetqualität; Teilnahme nur via Smartphone).	My technical equipment was insufficient (e.g. webcam or internet quality, participation only via smartphone).
Having privacy concerns	Es störte mich, dass andere dadurch Einblick in meine Privatsphäre haben (z.B. Zimmereinrichtung, ggf. andere Personen im Raum).	It made me feel uncomfortable that others have insights into my privacy (e.g. decor of the room, maybe other people in the room).
Feeling uncomfortable	Mir war es unangenehm, mich per Webcam zuzuschalten (z.B. Schüchternheit; Ungewohntheit, das eigene Bild zu sehen; unpassendes Outfit).	It made me feel uncomfortable to join the class via webcam (e.g. shyness, unusual to see one's own picture, outfit not adequate).
Use in compliance with others	Ich habe meine Webcam-Nutzung der Allgemeinheit angepasst (z.B. nur dann angeschaltet, wenn die meisten meiner Kommilitonen/innen dies auch gemacht haben).	I adapted my webcam use to that of the group (e.g. turning it on only when the majority of fellow students did so as well).
Teacher-student interaction (German original by Kauper et al., 2012)	Von den Dozierenden fühlte ich mich ernstgenommen.	I felt taken seriously by the lecturers.
	Die Dozierenden waren mir gegenüber freundlich und respektvoll.	The lecturers were friendly and respectful towards me.
	Mit den Dozierenden kam ich gut zurecht.	I got along well with the lecturers.
Social presence, subscale open communication (Diaz et al., 2010)	Ich habe mich beim Unterhalten via online Medien wohlgefühlt.	I felt comfortable conversing through the online medium.
	Bei der Teilnahme an Kursdiskussionen habe ich mich wohlgefühlt.	I felt comfortable participating in the course discussions.
	In der Interaktion mit anderen Kursteilnehmenden habe ich mich wohlgefühlt.	I felt comfortable interacting with other course participants.
Social presence, subscale group cohesion (Diaz et al., 2010)	Ich habe mich wohlgefühlt und hatte ein Gefühl von Vertrauen, eine andere Meinung als Kursteilnehmende zu vertreten.	I felt comfortable disagreeing with other course participants while still maintaining a sense of trust.
	Ich hatte das Gefühl, dass mein Standpunkt von anderen Teilnehmenden anerkannt wurde.	I felt that my point of view was acknowledged by other course participants.
	Online Diskussion helfen mir dabei, ein Gefühl von Zusammenarbeit zu entwickeln.	Online discussions help me to develop a sense of collaboration.

Note. All items had to be answered on a 6-point Likert scale: strongly disagree; disagree; rather disagree; rather agree; agree; strongly agree. The only exception is the item asking for webcam use with the answer scale: never, seldom, sometimes, often, and always.

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