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Videoconferencing fatigue and online student engagement among Filipino senior high school students: A mixed methods study

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Introduction: The ubiquity of online classes during the COVID-19 pandemic induced the widespread use of videoconferencing applications. However, the prolonged use of these applications can lead to videoconferencing fatigue. Drawing from an online survey sample of 215 senior high school students from a selected private university in Manila, Philippines, this mixed methods study examines videoconferencing fatigue and its relationship with online student engagement (OSE) during the COVID-19 pandemic.

Materials and methods: This study utilized a convergent triangulation research design. The quantitative strand was cross-sectional in nature. The constructs were measured using the Zoom Exhaustion and Fatigue Scale and Online Student Engagement Scale. Bivariate and multivariate statistical tests were used to determine the significance of the relationships between variables. The qualitative strand utilized a descriptive design. Narrative data were collected through an open-ended survey question and analyzed using content analysis.

Results: Quantitative results indicate moderate to high levels of videoconferencing fatigue among student respondents. Moreover, higher levels of OSE were observed among those who endured higher visual fatigue and attended videoconferences more days a week. Qualitative findings demonstrate various manifestations of videoconferencing fatigue among students and relate it with decreased energy to perform academic tasks and learning absorption. However, the qualitative analysis also reveals students' perceived need for videoconferencing to learn online.

Discussion: The nuanced insights from both strands highlight that despite their perceived negative impacts of videoconferencing, students had to tolerate visual videoconferencing fatigue in order to engage meaningfully in online classes.

KEYWORDS

COVID-19, high school, online learning, student engagement, videoconferencing fatigue, zoom fatigue

Introduction

Education is one of the sectors greatly affected by the (COVID-19) pandemic since distance learning has become a need rather than an option. The United Nations Educational Scientific and Cultural Organization (United Nations Educational Scientific and Cultural Organization [UNESCO], 2022) estimated that 91.3% of students worldwide have shifted to online learning since early 2020. The Philippines is one of the several countries worldwide with the longest period of distance learning since March 2020 (Westerman, 2022). The government had initially planned to gradually return classes to on-campus mode in 2022; however, the supposed pilot implementation of in-person classes had been suspended due to the sudden spike of COVID-19 cases in January (Cabalza, 2022). This delay in the resumption of face-to-face and extension of online learning means that students and educators will continue to rely on digital technologies to sustain their engagement in formal education.

Videoconferencing is a particular information and communications technology (ICT) that has become a ubiquitous tool for pure online education at all levels in the country. Videoconferencing can be broadly defined as synchronous or simultaneous visual and audio communication between two or more persons using an electronic device such as a smartphone, computer, and other computing gadgets (Bauce et al., 2018). Even before the pandemic, systematic reviews have established the utility and effectiveness of videoconferencing for educational purposes (Chipps et al., 2012). Videoconferencing applications, such as Zoom, Google Meets, and Microsoft Teams, provide a platform for teachers and students to have real-time, synchronous interactions. These applications offer ICT affordances to facilitate interactive discussions and other class activities. In addition, Videoconferencing helps create and maintain students' social connections with teachers, students, and distant loved ones, especially since in-person interactions had been constrained because of the social distancing and lockdown measures implemented during the time of COVID-19. However, using videoconferencing to participate in pandemic-induced remote education has not been without challenges. Empirical evidence reveals that Filipino students from disadvantaged sectors experience a lack of gadgets and access to reliable Internet to have effective videoconferencing-facilitated classes (Cho et al., 2021). Another problem related to this mode of learning that emerged during the pandemic is the exhaustion and tiredness that students develop because of the prolonged use of videoconferencing applications. This phenomenon is coined as 'videoconferencing fatigue' (Nadler, 2020; Riedl, 2021).

Empirical reports have demonstrated how Filipino students' negative experiences related to using digital educational tools can lead to poor educational outcomes and dissatisfaction with learning (Cho et al., 2021). Furthermore, meta-analytic evidence suggests that academic-related stress is negatively linked to academic performance (Ahmady et al., 2021). Hence, we suspect that videoconferencing fatigue can also be a deterrent to the overall educational experience of students. Specifically, our outcome variable of interest in this present study is online student engagement, which refers to students' skills, emotions, participation, and performance regarding their involvement in online classes (Dixson, 2015).

Literature review

Conceptualizing videoconferencing fatigue

Videoconferencing fatigue is often called *Zoom Fatigue*, as Zoom has become the most ubiquitous platform for this function. The term "Zoom Fatigue" started receiving prominence among journalistic circles to signify the collective sense of exhaustion induced by engaging in videoconferences that had become more widespread during the COVID-19 pandemic (Wiederhold, 2020). This article uses the term videoconferencing fatigue to signify that we are interested in all types of videoconferencing platforms used by students for learning. Videoconferencing fatigue appeared in scholarly literature towards the latter part of 2020, and researchers have since attempted to describe this phenomenon. Nadler (2020) theorizes videoconferencing fatigue as a form of computer-mediated communication exhaustion caused by cognitive over-exertion to interact using these new platforms meaningfully. This substantial increase in cognitive effort can lead to stress during and after videoconferencing. Aside from cognitive load, Bailenson (2021) adds that extended periods of close-up eye gaze and staring at one's face at the screen contribute to videoconferencing fatigue, which is further enabled by the lack of physical mobility during meetings. Epstein (2020) suggests that the lack of synchrony in communication and the lack of sensory dynamism also contributes to the sense of fatigue developed during videoconferencing.

The construct "videoconferencing fatigue" was further developed by Fauville et al. (2021a), who pursued the creation of a psychometrically sound tool to measure the said phenomenon, called the "Zoom Exhaustion & Fatigue Scale" (ZEF). Fauville et al. (2021a) posit that videoconferencing fatigue has five dimensions. The first is *general fatigue*, which refers to the sense of being tired, exhausted, and mentally drained after videoconferencing. Second is *visual fatigue*, manifested by unpleasant eye and vision symptoms induced by videoconferencing. Third is *social fatigue*, which refers to the avoidance of social interactions after videoconferencing. Fourth is *motivational fatigue,* which is depicted by the lack of drive to engage in other activities after videoconferencing. Last is

emotional fatigue, which refers to moodiness and irritability related to videoconferencing.

The development of ZEF (Fauville et al., 2021a) stimulated empirical investigations to explore the prevalence and determinants of videoconferencing fatigue. Majority of the respondents in recent research using this tool demonstrate moderate to high levels of videoconferencing fatigue (Fauville et al., 2021a; Oducado et al., 2021). Evidence reveals that videoconferencing fatigue is influenced by gender (Fauville et al., 2021b; Oducado et al., 2021), non-verbal mechanisms, including face dissatisfaction (Fauville et al., 2021b; Ratan et al., 2021), psychological attributes of users (Ebardo et al., 2021; Fauville et al., 2021a), and nature, duration, and frequency of meetings (Bennett et al., 2021; Nesher Shoshan and Wehrt, 2021; Oducado et al., 2021).

Videoconferencing fatigue in online class settings

Many of the earlier investigations on videoconferencing fatigue prior to the release of ZEF by Fauville et al. (2021a) were conducted in educational settings during the pandemic. A cross-sectional study conducted among engineering students in 2020 suggests that 70% of the students experience zoom fatigue (Asgari et al., 2021). Samara and Monzon (2021) explained that the disruption of the human communication component of learning and the demands to multitask while using Zoom increased the mental and physical aches students feel because of prolonged videoconferencing. Moreover, a qualitative case study has noted that in the context of e-learning, individual, situational, communication, and environmental factors influence the extent university students develop videoconferencing fatigue (Massner, 2021).

On the other hand, there is still a limited amount of literature that utilized ZEF to observe videoconferencing fatigue in the student population. First is the study of Oducado et al. (2021), which suggests that females, from lower year levels, with low academic performance, more gadgets, better videoconferencing attitudes, and those attending longer and more frequent virtual meetings exhibited higher levels of videoconferencing fatigue. Second is the work of Ebardo et al. (2021), which determined boredom, escapism, and information overload as predictors of videoconferencing fatigue. Third is the field experiment of Hezemans (2021), which noted zoom fatigue as a factor that influences certain aspects of group creativity among students. However, there is a dearth in the literature that examines the effect of videoconferencing fatigue on learning outcomes. An incidental qualitative finding by Cleofas (2021) shows that the energy-draining nature of synchronous videoconference-facilitated classes is a barrier to practicing self-care and engaging in online classes; however, this particular study did not make use of ZEF.
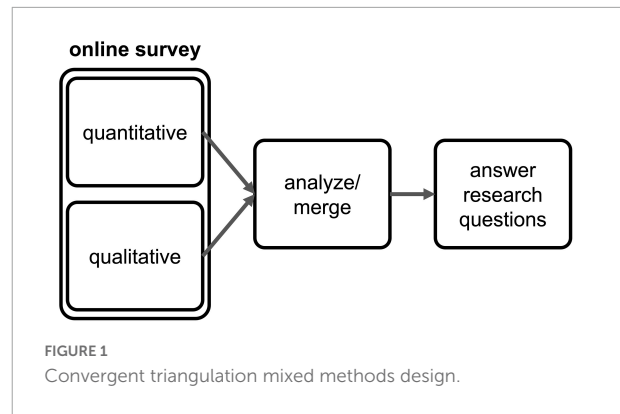
Research gaps and study objectives

Majority of studies that tackled videoconferencing fatigue examined it as an outcome variable. This present investigation contributes to the literature by exploring it as a phenomenon that can affect functional outcomes, specifically student engagement. Moreover, this study adds to the knowledge regarding videoconferencing fatigue in the school population by focusing on its prevalence and effects among senior high school students, in contrast to previous research that involved university students and general adults. Specifically, this present mixed methods study aims to address these gaps by addressing the following research objectives. This study aims to: (1) describe videoconferencing fatigue among senior high school students; (2) examine the relationship between videoconferencing fatigue and online student engagement.

Materials and methods

Study design and participants

This study made use of a concurrent triangulation mixed methods design. We adhered to GRAMMS (Good Reporting of a Mixed Methods Study; O'Cathain et al., 2008). In a triangulation mixed methods design, quantitative and qualitative data are collected and analyzed concurrently, with the intent to interrelate and identify possible discrepancies from both strands (Plano Clark et al., 2008). For the quantitative strand (QUAN), a cross-sectional approach was used, while for the qualitative strand (QUAL), a descriptive qualitative approach was utilized. In this study, QUAN and QUAL receive relatively equal weighting; both strands were emphasized in addressing the research objectives (Plano Clark et al., 2008). The mixed methods approach is visualized in **Figure 1**.

The present study's target population was the 2021–2022 batch of senior high school students (grades 11 and 12) from a selected private university in Manila, Philippines. Data were collected during the period when all classes in said university

were conducted purely online due to the COVID-19 pandemic, and all teachers and students made use of videoconferencing for academic purposes. Based on G*power analysis, a minimum of 74 respondents was needed for the total number of potential predictors (13 predictors, power = 0.95, p = 0.05). A total convenient sample of 215 students participated in our survey. One hundred percent completed the quantitative segments of the survey, while 153 (71.16%) answered the qualitative question in the form.

Instrumentation

The five-part online survey was created using *Google Forms* and collected quantitative and qualitative data. The first part determined the demographic profile of the respondents, which included the age, sex assigned at birth (coded 0 for females and 1 for males), grade level (11 or 12), and average monthly household income based on the brackets recommended by the Philippine Statistics Authority. The second section measured the respondents' digital use profile, which included the number of gadgets used, average internet speed at home [rated as generally slow (less than 4 Mbps), average (4 to 40 Mbps), and generally fast (greater than 40 Mbps)], the estimated number of videoconferencing days per week, and the number of videoconferencing hours in a day. Demographic and digital use profiles are included in the model to control for possible confounding effects.

The third part of the instrument is the Zoom *Exhaustion and Fatigue Scale* (ZEF) developed by Fauville et al. (2021a), which was used to quantify the level of videoconferencing fatigue of the students. ZEF is a 15-item questionnaire that covers the five dimensions of fatigue, which are general fatigue, visual fatigue, social fatigue, motivational fatigue, and emotional fatigue. Every domain was comprised of three items. Each item was answered via a five-point Likert scale (1 = not at all, 5 = extremely). A sample question is, "How mentally drained do you feel after video conferencing?" Cronbach's alpha for each domain was above 0.8, indicating acceptable scale reliability (Fauville et al., 2021a). For this study, no modifications were made to the ZEF scale when it was administered. In our sample, the overall Cronbach alpha score of the ZEF scale was 0.895 and ranged from 0.716 to 0.891 per domain.

The fourth part of the survey is the *Online Student Engagement Scale* (OSE) created by Dixson (2015), which was used to quantitatively measure students' engagement during online classes. OSE is a 19-item scale that measures skills (5 items), emotion (5 items), participation (6 items), and performance (3 items) related to online student engagement. Each item was also answered via a five-point Likert scale (1 = not at all characteristic of me, 5 = very characteristic of me). An example item statement is, "I take notes during presentations and video lectures." The overall scale demonstrated adequate

reliability (Cronbach's alpha > 0.80; Dixson, 2015). In our sample, the Cronbach alpha score of the OSE scale was 0.909 and ranged from 0.767 to 0.812 per domain. For our study, OSE is treated as a composite, unidimensional construct.

The final section of the online survey is an open-ended question: "*How does videoconferencing affect your engagement in school?*" The students were afforded an unlimited textbox where they could type their answers as liberally as they could. The narratives collected from this question were used in the qualitative strand of the study. This process of using self-administered and survey-facilitated open-ended questioning has been used by recent empirical studies using qualitative approaches in both mono-method (Knudsen et al., 2021) and multi-method designs (Cleofas, 2022). Open-ended surveys are also appropriate for qualitative designs that lean toward basic perspective-focused and descriptive approaches (as opposed to experiential, interpretive, or reflective approaches) and for non-vocalized texts treated with qualitative content analysis (Hsieh and Shannon, 2005; Elo and Kyngäs, 2008).

Data collection procedure and ethical considerations

Our research procedure adhered to the principles of the Declaration of Helsinki. After the protocol of the study was granted ethical clearance by the De La Salle University Integrated School, we secured the parental consent of the SHS students with the assistance of point persons from different SHS sections via online correspondence. For students whose parents had signified consent, the online survey link was sent via email and/or social media private messaging. The survey was active during the whole month of November 2021. Informed assent was digitally secured using the first page of the survey. All collected data were stored in an encrypted cloud accessible only to the research team. Minimal risk is identified for this study, specifically a low probability of mild psychological distress. To address this, we provided our contacts in the survey form and encouraged respondents to contact us for any unpleasant psychological reactions while answering the test. These students would be referred to qualified psychological health professionals provided by the school. Throughout the duration of this study, no untoward incidents were noted, and no respondents required psychological services.

Data analysis procedure

For the quantitative data, frequency, percentage, mean and standard deviation were used to describe the key variables. To determine the level of videoconferencing fatigue and online student engagement, the means were interpreted as low (1.00–2.33), moderate (2.34–3.67), and high (3.68–5.00). The

domains of videoconferencing fatigue and the demographic and digital use profiles were then tested for correlation with OSE using bivariate statistics (Pearson R for continuous variables, independent t-test for dichotomous, and one-way ANOVA for multichotomous). The significant correlates were then included in the multiple regression model for the significant predictors of OSE. Kolmogorov–Smirnov results were non-significant, denoting normality of the distribution. Significance was set at $p < 0.05$. JASP version 0.16 was used for the analyses.

Qualitative content analysis was used for the narratives ($n = 153$). For the first objective, the process was deductive since the themes were already pre-identified based on the literature and scale used (the five domains of videoconferencing). Deductive analysis aims to organize the emerging concepts and assign them to the domains (Hsieh and Shannon, 2005). For the second objective, the process was inductive, such as the themes were formed based on the emergent lower-level concepts gleaned from the narratives (Elo and Kyngäs, 2008). We arrived at three themes for objective number two.

Data from QUAN and QUAL were integrated using a simultaneous bidirectional strategy, wherein we went back and forth the data of both strands as they were being developed to see convergences and divergences to make the analysis more robust (Moseholm and Fetters, 2017). To ensure trustworthiness (Lincoln et al., 2018), we familiarized ourselves with the data by reading and rereading the transcripts. Regular meetings were held to arrive at a consensus on the data analysis. Findings were also peer-reviewed by an expert on online education. Another aspect of the methodology that affords more credibility is that qualitative data collection was via a self-administered online survey. The absence of the researcher may provide a sense of anonymity which can improve the honesty and authenticity of the shared narratives. Moreover, the survey method allowed more participants to engage, making the current sample size multiple times larger than what is usually expected from a mono-method qualitative study. This assured vetting and data thickness despite the lack of opportunities to probe. Finally, all analysis-related meetings were recorded and logged to serve as our audit trails.

Results

Quantitative strand: Descriptive statistics for videoconferencing fatigue, online student engagement, and other key variables

Table 1 presents the descriptive statistical results for the study's key variables that address the first objective. For the

TABLE 1 Descriptive statistical results of key variables ($N = 215$).

Key variables	n/mean	%/SD
Demographic profile		
Age	17.00	0.809
Sex assigned at birth		
Male	58	27.0%
Female	157	73.0%
Grade level		
Grade 11	100	46.5%
Grade 12	115	53.5%
Digital use profile		
Number of gadgets owned	2.60	0.692
1–2 gadgets	107	49.8%
3 gadgets or more	108	50.2%
Speed of Internet subscription		
Greater than 40 Mbps (generally fast)	74	34.4%
4 to less than 40 Mbps (average)	131	60.9%
Less than 4 Mpbs (generally slow)	10	4.7%
Videoconferencing days per week	5.47	1.09
Videoconferencing hours per day	7.20	3.03
Videoconferencing fatigue [a]		
General fatigue	4.04	0.712
Visual fatigue	3.34	1.07
Social fatigue	3.56	1.08
Motivational fatigue	4.16	0.772
Emotional fatigue	3.39	1.05
Online student engagement [a]	3.42	0.642

[a]Low = 1.00–2.33; moderate = 2.34–3.67; high = 3.68–5.00.

demographic profile, the majority of the respondents are 17 years old (mean age = 17 ± 0.809), females (73%), and grade 12 (53.5%). In terms of digital use profile, the majority of the students own three gadgets or more (50.2%; mean number of gadgets = 2.60 ± 0.692), have average Internet speeds of 4 to less than 4 Mbps (60.9%), spend 5.47 ± 1.09 days per week, and 7.20 ± 3.03 h per day in videoconferencing. As for videoconferencing fatigue, moderate levels were reported in terms of visual fatigue (3.34 ± 1.07), social fatigue (3.56 ± 1.08), and emotional fatigue (3.39 ± 1.05), and high levels of general fatigue (4.04 ± 0.712) and motivational fatigue (4.16 ± 0.772). Lastly, the students demonstrated moderate online student engagement (3.42 ± 0.642).

Qualitative strand: Concepts depicting the dimensions of videoconferencing fatigue

Table 2 presents the overview of the qualitative findings of the study. This section presents the themes and concepts from the qualitative analysis that address the study's first objective.

TABLE 2 Overview of qualitative findings in the study.

	Research objective 1: To describe videoconferencing among senior high school students	Research objective 2: To examine the relationship between videoconferencing fatigue and online student engagement
Emergent Themes	1.1. General fatigue: energy drain causing a general sense of exhaustion	2.1. Lesser energy for academic tasks due to videoconferencing-induced exhaustion
	1.2. Visual fatigue: decreased eye health causing dizziness and loss of focus	2.2. Poor absorption of learning through videoconferencing compared to in-person classes
	1.3. Social fatigue: lack of energy for social interactions and dissatisfaction with online communication	2.3. Accepting videoconferencing as a necessary tool for education during the pandemic
	1.4. Motivational fatigue: decreased ability to focus and resilience to cope with challenges	
	1.5. Emotional fatigue: stress, anxiety, and moodiness	

Theme 1.1. General fatigue: Energy drain causing a general sense of exhaustion

Student respondents report **being drained of energy** because of long hours of videoconferencing for classes. R165 shares, "*I find it extremely draining, and that energy expenditure makes it challenging to actively participate in class and to do other school works after said videoconferencing.*" Due to the depletion of physical energy because of videoconferencing, students feel a **general sense of exhaustion** regarding school and other aspects of their lives, causing them to need more periods of rest across the day. R012 mentions, "*I find that I tend to take naps more often because of my exhaustion . . . I end up having the energy to do schoolwork late in the evening, too early in the morning.*"

Theme 1.2. Visual fatigue: Decreased eye health causing dizziness and loss of focus

The students have also noted a videoconferencing-induced decline in eye function. They noticed symptoms of **decreased eye health**, such as pain. R169 writes, "*. . .There was a time when my eyes began to hurt. And it really stresses me out. . ..*" Another indicator of constrained vision they mentioned is **dizziness and loss of focus**. Long periods of facing the monitor have made them feel lightheaded. R166 mentions, "*. . .it makes me dizzy because of radiation from the laptop and long hours of staring at it.*"

Theme 1.3. Social fatigue: Lack of energy for social interactions and dissatisfaction with online communication

Students also note that videoconferencing had detrimental impacts on their social well-being. Videoconferencing-induced exhaustion has caused students to **lose energy for social interactions**. R064 mentions, "*videoconferencing has also made me want to be much more isolated compared to a face-to-face setup, and I'd rather sleep after class than talk to other people.*" Moreover, the students lament that they are **dissatisfied with online communication**, claiming that it is less personal than in-person communication. R049 writes, "*. . .it is harder to initiate a conversation in a silent breakout room more than it is to do so when you are physically gathered up together in a small space . . ..*"

Theme 1.4. Motivational fatigue: Decreased ability to focus and resilience to cope with challenges

Respondents lament that long periods of videoconferencing have caused students to feel less motivated in academics because they claim that it induces **decreased ability to focus on tasks**. For R036, the monotonous routine related to videoconferencing has reduced their motivation to engage in classes, declaring, "*It kind of lessens my motivation to study sometimes because it is the same thing every day and every week. You wake up, face the computer, try to study, leave the conference, then do other things.*" Moreover, this videoconferencing-induced demotivation has **decreased students' resilience to cope with challenges**. R114 shares, "*I get really drained to the point that sometimes I don't want to do my requirements in advance.*"

Theme 1.5. Emotional fatigue: Stress, anxiety, and moodiness

Students express that videoconferencing has triggered various negative emotions. They share that videoconferencing complicates the **stress and anxiety** they already feel due to the difficulties of new normal learning. R022 mentions, "*. . .The online setup stresses me out more and takes a greater toll on my mental and emotional well-being.*" Moreover, students claim that videoconferencing enhances their **moodiness**, especially when they are overwhelmed with other tasks. R102 aptly describes, "*videoconferencing generally makes me tired, irritable, and bored.*"

Qualitative strand: Concepts depicting the dimensions of videoconferencing fatigue

This section presents the results from the inferential statistical analyses that address the study's second objective.

Bivariate results on the correlation of profile variable and videoconferencing fatigue with online student engagement

Table 3 shows the bivariate statistical results indicating significant correlations between independent variables of interest and online student engagement. Findings suggest that grade level ($t = 2.25$, $p = 0.026$), videoconferencing days per week ($r = 0.560$, $p < 0.001$), and visual fatigue ($r = 0.187$, $p = 0.006$) are significantly correlated with online student engagement. Higher online student engagement was observed among graduate students engaging in more videoconferencing days per week and having higher scores in visual fatigue.

Multiple regression results

Table 4 shows the results of the multiple regression test among the significant correlates and their predictive relationship with online student engagement. The overall model significantly predicts 9.74% of the variance of online student engagement ($F = 7.59$, $p < 0.001$). This means that the current model can explain approximately one-tenth of the variability of the online student engagement of the respondents. Findings suggest that students who spend more days a week in videoconferencing ($B = 0.1304$, $p = 0.001$) and have higher levels of visual fatigue ($B = 0.0801$, $p = 0.043$) have higher levels of online student engagement. Grade level no longer yielded significant results.

Qualitative strand: Themes on the relationship between videoconferencing fatigue and online student engagement

This section presents the qualitative themes that address the study's second objective, as seen in **Table 2**.

Theme 2.1. Lesser energy for academic tasks due to videoconferencing-induced exhaustion

A major emerging pattern in the students' narrative responses demonstrates how videoconferencing takes away the energy that could be spent on performing academic tasks outside synchronous classes, hence decreasing their overall student engagement. R187 explains their shared experiences, "*After long hours doing videoconferencing, it is definitely physically and mentally draining for students to continue working after classes.... Moreover, they have to continue studying, doing classwork, and making group projects....*" The sense of exhaustion after videoconferencing causes the need to increase rest periods, which consequently affects daily study habits. R028 writes, "*I become less enticed to do schoolwork in the afternoon, after my classes. I end up doing school mostly at night because videoconferencing drains me....*" The students experience and understand the toll that long periods of videoconferencing while

TABLE 3 Bivariate statistics on the correlation of demographic profile, digital use profile, and videoconferencing fatigue with online student engagement.

Variables	Mean (SD)	Test statistic	p-Value
Demographic profile			
Age[a]	–	−0.098	0.150
Sex assigned at birth[b]		1.94	0.053
Male	3.29 (0.741)		
Female	3.48 (0.596)		
Grade level[b]		2.25*	0.026
Grade 11	3.53 (0.665)		
Grade 12	3.33 (0.610)		
Digital use profile			
Number of gadgets owned[a]	–	0.115	0.091
Perceived internet speed[c]		1.28	0.295
Greater than 40 Mbps (generally fast)	3.52 (0.614)		
4 to less than 40 Mbps (average)	3.37 (0.642)		
Less than 4 Mpbs (generally slow)	3.41 (0.818)		
Videoconferencing days/week[a]	–	0.560***	< 0.001
Videoconferencing hours/day[a]	–	0.110	0.108
Videoconferencing fatigue[a]			
General fatigue	–	0.014	0.843
Visual fatigue	–	0.187**	0.006
Social fatigue	–	−0.075	0.276
Motivational fatigue	–	−0.101	0.140
Emotional fatigue	–	−0.041	0.555

Tests used: [a]Pearson R Correlation.
[b]Independent t-test.
[c]Oneway ANOVA.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

remaining sitting and sedentary can take on their health, which have negative consequences on their studies. R119 verbalizes, "*videoconferencing decreases my engagement in school as it is very tiring, and not being able to move around a lot irritates me.*"

Theme 2.2. Poor absorption of learning through videoconferencing compared to in-person classes

Many students claim that they learn less in classes delivered via videoconferencing. Their exhaustion can lead to a lack of focus when a synchronous online lecture is ongoing. R175 mentions, "*...it affects my focus as videoconferencing tends to make me feel tired and distracted sometimes. Thus, I would need to take a break from time to time to avoid spacing out.*"

TABLE 4 Multiple regression test of demographic, digital use, and videoconferencing fatigue determinants of online student engagement.

Variables	Estimate	SE	t	p-Value
Grade level (reference = Grade 11)				
Grade 12	−0.1258	0.0857	−1.47	0.143
Videoconferencing days per week	0.1304**	0.0396	3.30	0.001
Visual fatigue	0.0801*	0.0400	2.01	0.043

Model: $F = 7.59$, $R^2 = 0.0974$, and $p < 0.001$.

$*p < 0.05$, $**p < 0.01$, and $***p < 0.001$.

Contributing to the videoconferencing fatigue and hindrances in learning are the electronic issues that students encounter during classes, such as poor connectivity and loss of electricity. R016 narrates, "*Sometimes I feel like I'm behind my classmates . . . but there are times that there will be a brownout in our community that will make our WIFI unstable, so I'm having a hard time coping up with the lessons. . ..*" Resounding from the comments of the participants is the dissatisfaction they generally have with online-based learning and preference for in-person classes, which they claim would improve their learning and overall engagement. They lament the monotony of learning experiences because of the limited affordances provided by videoconferencing applications. They claim that they desire face-to-face interactions with teachers and classmates for a fuller learning experience. R158 writes, "*I feel like I am losing interest in actually studying and absorbing education. Human interaction and physical socialization are vital in ensuring that the school becomes a conducive place for learning, which videoconferencing cannot fully provide. . ..*"

Theme 2.3. Accepting videoconferencing as a necessary tool for education during the pandemic

Despite the reported disadvantages of videoconferencing, its resultant fatigue and its negative impact on student engagement in general, some of the students understand that in the context of the current pandemic, videoconferencing is an indispensable part of the educational experience that makes any form of student engagement in the new normal possible in the first place. R062 declares, "*It has helped in the continuance of my education. It is the closest experience we can have to a live interaction, even if it's just virtually.*" Despite being a less preferred medium for communication compared to in-person conversations, videoconferencing is the only way for them to have actual interactions with teachers and other students. R198 explains, "*It's currently our only choice for communicating and attending class, so we have no choice but to attend these meetings. It's not the best form of communicating, but at the very least, it gets the job done of conveying messages to each other, especially during classes.*" Some students also claim that there are unique advantages of videoconferencing, especially when used effectively by teachers. For instance, R184 writes, "*It's really

helpful somehow; whenever a student is absent, they can just easily play the recorded meeting on zoom."

Integration of quantitative and qualitative findings

Students suffer from videoconferencing fatigue

In terms of the first objective of the present study, the pronounced extent of videoconferencing fatigue among the SHS students in the study is evinced by quantitative and qualitative findings. Quantitative results suggest that students have moderate (visual, social, and emotional) to high levels (general and motivational) of videoconferencing fatigue. Furthermore, qualitative findings demonstrate the various manifestations of how students experience each dimension of videoconferencing fatigue and how these affect not only their studies but also their health and social lives.

The relationship between videoconferencing fatigue and online student engagement is nuanced

For the study's second objective regarding the relationship between videoconferencing fatigue and online student engagement, the answer is not as straightforward as the first. From themes 2.1 and 2.2 that emerged from qualitative analysis, it can be gleaned that videoconferencing-induced exhaustion can deter student engagement. Specifically, long videoconferencing periods can deplete energy for academic-related tasks and decrease the absorption of learning. However, statistical findings from the regression model suggest that not all domains of videoconferencing are significant predictors of OSE, except for visual fatigue. Surprisingly, visual fatigue positively predicts OSE. This means that students endure visual fatigue from videoconferencing to engage in their online classes. This finding is corroborated by another significant quantitative positive predictor (videoconferencing days per week) and theme 2.3 from qualitative analysis. Student narratives reveal that they accept and understand that videoconferencing is a primary requirement to conduct online classes in the first place. Hence, to be meaningfully involved in online classes, they must attend videoconferencing many days a week despite experiencing increased visual fatigue. A fitting illustration for this ambivalent link between videoconferencing visual fatigue and online student engagement is a quote from R068: "Videoconferencing is going well with me, and I prefer it this way. However, it does put a toll on my health, mostly my eyes after hours on the screen."

Discussion

This convergent mixed methods study sought to describe videoconferencing fatigue and examine its relationship with

online student engagement among senior high school students during the second year of COVID-19 pandemic-induced online education in the Philippines. Theoretically, this study extends the literature on the effects of computer-mediated fatigue on functional outcomes, such as learning. Based on our knowledge, this is the first study that pursued a mixed methods approach to understanding the phenomenon of videoconferencing fatigue in education.

Consistent with previous research (Fauville et al., 2021a; Oducado et al., 2021), the quantitative findings of the present study indicate that students have moderate to high levels of videoconferencing fatigue. Among the five domains, general and motivational fatigue emerged as the highest scoring. Qualitative findings demonstrate specific manifestations of videoconferencing fatigue per domain contextualized to the participants' experiences as students. Our qualitative findings corroborate with the study of Nesher Shoshan and Wehrt (2021) among employees who also experienced various losses from videoconferencing. Many of the manifestations narratively reported by the students, such as a general sense of lack of energy, eye strain, dissatisfaction with interactional patterns, anxiety and moodiness, and decreasing motivation for tasks, had been demonstrated in a case study among college students and teachers (Massner, 2021).

Moreover, the quantitative and qualitative findings for the second research objective reveal the nuanced relationship between videoconferencing fatigue and online student engagement. On the one hand, qualitative analysis demonstrates how videoconferencing fatigue can constrain student engagement. Students report that videoconferencing takes away the energy they would have had for performing other academic tasks. This is confirmed by previous research that demonstrated videoconferencing-induced exhaustion due to online classes makes students demotivated in learning, unable to practice health-restoration activities, and dissatisfied with their academic performance (Cleofas, 2021). Moreover, qualitative results of the present study suggest that students engage poorly in videoconference-enabled classes because they have better learning absorption during face-to-face classes. Previous studies have likewise demonstrated that engagement in prolonged virtual meetings increases the longing to have in-person interactions with peers and colleagues (Nesher Shoshan and Wehrt, 2021). Moreover, evidence has already indicated that students reported declining overall online learning experience as the pandemic-induced remote education is prolonged (Maqableh and Alia, 2021).

On the other hand, our quantitative inferential results indicate that students with higher scores for online student engagement also exhibit higher levels of visual videoconferencing fatigue. This is surprising since previous evidence has linked poor grades to higher videoconferencing fatigue (Oducado et al., 2021). Another significant positive

predictor of OSE is the number of days with videoconferencing per week, which runs parallel to findings of previous studies demonstrating that students and other school entities are involved in more online classes and tasks to perform well in school (Cleofas, 2021; Maqableh and Alia, 2021; Oducado et al., 2022). This means that students have to overuse their eyes to be able to attend more videoconferences to properly engage in online learning. Ophthalmology literature has noted the rise of cases of eye strain, dry eyes, and other vision problems during the COVID-19 pandemic because of the increased screen time individuals spend while on lockdown (Mohan et al., 2021; Prescott, 2021). This finding is supported by the last qualitative theme depicting the perceived necessity and salience of videoconferencing as an indispensable aspect of online classes. This seemingly implies that in pandemic-induced education, students have "no choice" but to participate in videoconference sessions, and experience the inconveniences of videoconferencing, just to continue learning, as demonstrated in previous research (Cleofas, 2021). However, evidence also suggests that despite the hardships students experience, some students can still have positive sentiments toward videoconference-facilitated classes, especially regarding their convenience and safety related to the threat of COVID-19 (Hussein et al., 2020; Maqableh and Alia, 2021) and with it a more satisfying online educational experience.

Conclusion

The present study signifies the presence of videoconferencing fatigue among SHS students who are involved in pure online classes during the COVID-19 pandemic. The insights from student narratives also highlight how videoconferencing fatigue is experienced in the specific context of online education. Moreover, findings suggest that students spend more days a week videoconferencing and endure visual fatigue to achieve optimum online student engagement. However, despite the perceived importance of videoconferencing for an online class, students also claim that the fatigue it causes can potentially decrease energy for the performance of academic tasks and absorption of learning, signifying the nuanced nature of the relationship between videoconferencing fatigue and online student engagement. Our study provides empirical evidence that despite their perceived negative impacts of videoconferencing, students had to tolerate visual videoconferencing fatigue to engage meaningfully in online classes.

Strengths and limitations of the study

The main strength of this study is its mixed methods design which provides deeper insights into the phenomenon

of videoconferencing fatigue in the context of online learning. However, we disclose some limitations of the study that can help temper the interpretation of our findings. First, the generalizability of the findings may be constrained since they were derived from a convenient sample from a single site. In addition, males were underrepresented in the sample. Moreover, our final model yielded a modest explanatory power; hence future studies may use more salient variables further to understand the relationship between videoconferencing fatigue and OSE. Also, since the qualitative data collection was done via survey instead of interviews, the chance to ask further questions to probe the responses could not be done. This inhibited a fuller realization of the credibility aspect of trustworthiness. Future researchers can consider more interpretive and reflective qualitative paradigms (e.g., phenomenology, narrative analysis) in exploring students' experiences in videoconferencing.

Implications and future studies

The results of the present study offer several implications for the stakeholders involved during pandemic-induced online learning among students. First, teachers and educational administrators should not make students sacrifice their overall eye health to participate meaningfully in online classes. Despite the indispensability of videoconferencing in delivering online education, faculty members can use non-videoconferencing based synchronous (e.g., real time chat-based discussions) and asynchronous strategies (e.g., pre-recorded lectures) to unburden the students with the cognitive and nonverbal overload they had to endure during videoconferencing. Administrators can continuously provide training and updates on emerging teaching strategies outside the realm of videoconferencing. Teachers should provide longer breaks between videoconferences to allow students to rest and regain their energy to engage meaningfully in other academic tasks. Faculty and school health personnel must provide eye health promotion information and programs. When in-person classes become feasible, school administrators must conduct eye assessments for all students to identify if they have experienced decline in vision.

Despite the lack of statistical significance between other domains of videoconferencing fatigue on student engagement, it must be noted the fatigue levels reported by the students are moderate to high, and student narratives demonstrate their negative effect on performance and knowledge acquisition. Hence, the promotion of the physical and mental health of the students must be sustained, especially during pandemic-induced online learning. Teachers and parents can be empowered to address the students' mental, physical, and visual health needs, during the period when online learning modality is needed to respond to public health crises like the COVID-19 pandemic. As societies and economies open as we enter a post-COVID world, educational policymakers must consider the gradual reopening of schools and in-classroom learning so that the use of videoconferencing tools will become more of an option than a daily necessity.

Future studies can consider the following foci to extend the insights found in this study. First is exploring potential mediators or moderators between videoconferencing fatigue, such as resilience, self-efficacy, and overall health, to address the uncanny relationship demonstrated by this present study. Second, videoconferencing fatigue can also be correlated with eye health and vision-related variables. Third is considering expanding the methods, like conducting longitudinal studies or sampling younger learners (elementary students), to ascertain whether videoconferencing fatigue and its relationship with OSE changes over time and with other age groups.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Integrated School, De La Salle University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

MD, JD, EO, and AP: conceptualizing, methodology, data gathering, and initial writeup. JC: conceptualizing, data analysis, and final writeup. All authors contributed to the article and approved the submitted version.

Acknowledgments

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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