ORIGINAL ARTICLE

# Online Learning and Its Short-term Impact on Digital Engagement and Digital-related Health Symptoms Amongst University Students During the COVID-19 Pandemic

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## ABSTRACT

**Introduction:** The COVID-19 pandemic has precipitated a rapid shift of learning and education from traditional means to digital platforms. This paper aims to examine the impact of online learning on digital engagement and digital-related health symptoms among university students one year into the coronavirus pandemic. **Methods:** Data was collected through a self-administered online questionnaire after ethical approval. The questionnaire was adapted from the previously published *Lifestyle Study in Youth Questionnaire*. Through the questionnaire, the perception of students toward online learning was probed and recorded. Digital engagement and digital-related health symptoms were compared before and during the COVID-19 lockdown. **Results**: The majority (97.5%) of respondents preferred face-to-face learning. The time spent on digital devices was 1.8 times higher during COVID-19 than before the COVID-19 lockdown (t-test = -18.86, $p<0.0001$). The total hours of sleep were reduced during COVID-19 lockdown (0.6 hours lesser) (t-test = -3.92, $p<0.0001$). The *Wilcoxon Signed Ranks Test* revealed significant changes in digital-related health symptoms (15 out of 17) due to the COVID-19 lockdown. Digital eye strain, dry eye syndrome, carpal tunnel syndrome, and upper quadrant postural and muscle strain emerged ($p<0.05$). **Conclusion:** Most university students favoured face-to-face learning compared to online learning. There was a two-fold rise in digital engagement during the COVID-19 lockdown. As a result, it has seemed to translate into reduced sleeping hours. The short-term impact of the coronavirus pandemic on digital-related health symptoms amongst university students was apparent. The long-term effects require further investigations to facilitate fact-based decision-making.
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**Keywords:** COVID-19, Digital, Eye strain, Face-to-face, Online learning

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## INTRODUCTION

Education and learning have been significantly transformed as we seek knowledge in the Information Age we live in (1,2). Electronics and digital technology grant us access to the Internet of Things. With the advent of electronic technology, learning environments have shifted from face-to-face to hybrid or open/distance learning (3,4). The earliest documented history of online learning can be traced back to as early as the 1960s (5). However, the online learning option has encountered scrutiny and hesitancy (6). Before the pandemic, education worldwide predominantly adopted traditional means of on-site teaching and learning (7). The recent COVID-19 pandemic has undoubtedly nudged education and learning towards an alternative direction, favouring technology for distance and online learning (8–10). The COVID-19 pandemic has triggered drastic educational changes due to the unexpected and rapid move to online learning remotely on digital platforms. The education sector in Malaysia was no exception. Malaysian institutions had to opt for online platforms since the Movement Restricted Order (MCO) was imposed by the Malaysian government in March 2020 (11). The movement control unambiguously altered the teaching and learning activities, and the students were restrained from attending physical lectures. Nonetheless, teaching and learning activities need to carry on. Nevertheless, this has brought a dramatic challenge to higher education institutions. Educators were obliged to instantaneously move to entire online teaching for teaching and learning activities. Various applications and platforms have been used in online teaching, which includes ZOOM, Microsoft Teams, WhatsApp groups, YouTube channels, Google Classroom, and many more

for learning purposes (12,13). Different individuals cope with online learning differently (14,15).

The increasing trend of electronic device usage has been alarming (6,16,17). Humans are exposed to electronic devices on a daily basis. There has been a dramatic surge in internet usage as a result of COVID-19 (8–10). Prolonged exposure to electronic displays and lack of outdoor activities lead to health issues (18–21). Prolonged digital usage has been linked to several health-related consequences, including inadequate sleeping time, psychological problems, vision problems, systemic diseases and cancer, non-communicable diseases and hormonal effect changes (22–24).

Online learning during the COVID-19 pandemic resulted in increased use of digital devices. Digital exposure poses a greater risk of developing digital eye strain-related symptoms. Digital eye strain is a rising health concern and is unswervingly proportionate to the duration of digital screen contact (24). Several studies postulated that digital devices trigger health concerns by radiating short high energy waves (25–27). These short waves enter the eyes and eventually damage the retinal cells' photochemical properties, leading to various eye problems ranging from dry eyes to macular degeneration (25–27). With the drastic shift to online learning, it has become unavoidable to spend more time in front of a computer or mobile screen (28). Prolonged computer usage has been associated with a higher incidence and severity of computer-related symptoms (29). Thus, it may negatively impact students' quality of life (2). Questions have been raised about the health implications of the prolonged use of digital devices associated with online learning. Some teaching institutions advocate maintaining online learning because online education seems to be a more affordable alternative due to the lower operating cost. As the impact of COVID-19 is foreseen to change future teaching and learning pedagogy, the effect of a one-year lockdown on digital eye strain will provide knowledge and guidelines to policy maker and educators in designing a better learning environment using the online learning platform. The findings from this study offer health information for consideration in making the decision. Current knowledge and management of online digital eye strain have been limited (30). This paper explores the relationship between sleeping patterns, digital engagement and digital-related health symptoms of university students after a one-year COVID-19 lockdown. The information from this study can be beneficial for future planning besides offering an overview of the health impact of the COVID-19 pandemic.

## MATERIALS AND METHODS

The study was approved by the institutional review board. Ethical approval was obtained from the UITM Research Ethic Committee [600-TNCPI (5/1/6) REC/05/2021 (UG/MR/441)]. This cross-sectional study adhered to the Declaration of Helsinki.

The data collection was conducted through a self-administered online questionnaire using the Google Forms platform in May 2021. The survey was distributed through class representatives of respective programs. The survey instrument used in this study was adapted from the validated Lifestyle Study in Youth questionnaire (31). There were three main sections in the questionnaire (Table I). Section one surveyed the perception of students towards face-to-face learning and online learning. Section two recorded the total hours spent in digital engagement and sleeping before and during the COVID-19 lockdown. Section three was designed to grade the severity of 21 digital-related health symptoms.

**Table I: Information about the survey questionnaire**

| Investigations | Questions | Scales used |
|---|---|---|
| Perception about online learning | 1. How do you rate the face-to-face learning?<br>2. How do you rate the online learning? | A 5-point Likert scale [1 – totally dislike, 2 – dislike; 3 – neutral; 4 – like; 5 – totally like] |
| Digital engagement | 1. Record the total hours to engage in digital devices in a day before and during COVID-19 lockdown.<br>2. Record the total hours of sleep in a day before and during COVID-19 lockdown. | - |
| Digital-related health symptoms | Rate the following visual symptoms:<br>• Blurred vision at near distance<br>• Blurred vision at far distance<br>• Difficulty or slowness in refocusing my eyes from one distance to another<br>• Eye strain<br>• Tired eye<br>• Dry eye<br>• Red eye<br>• Watery eye<br>• Sand sensation in the eye<br>• Itchiness<br>• Eye irritation<br>• Burning sensation in the eye<br>• Sensitivity to bright lights<br>• Eyes pain<br>• Neck pain<br>• Shoulder pain<br>• Upper back pain<br>• Lower back pain<br>• Fingers pain<br>• Hand/wrist pain<br>• Elbow/ Forearm pain | A 5-point Likert Scales [1 – never, 2 – rarely; 3 – sometimes; 4 – often; 5 – always] |

The Cochran's Sample Size Formula [no = ($Z^2$ p q)/($e^2$), where e is the desired level of precision, p is the (estimated) proportion of the population which has the attribute in question, q is 1 – p] with the confidence interval of 95% with a margin of 5% error was used to calculate the sample size. Random sampling strategy was adopted. The target sample size was 375. The inclusion criteria were full-time local university undergraduate degree students. The exclusion criteria were part-time and full-time students pursuing certificates, diplomas or postgraduate degrees. The online questionnaire was sent out to 375 students from the science disciplines (Health Sciences, Medicine, Pharmacy) and from non-science disciplines (Accountancy, Education and Business

Management) within the same public university.

Data collected and tabulated from Google Forms were analyzed using the Statistical Package for Social Sciences software version 23.0 (SPSS Inc. Chicago, IL, USA). Mann-Whitney U Test was used to compare the preference between online learning and face-to-face. The z-test was used to compare the preference distribution pattern between online and face-to-face learning. A frequency table was utilized to report the digital-related health symptoms linked to prolonged usage of digital devices. Wilcoxon Signed Ranks Test and paired t-test were used to compare data before and during the lockdown. Significance levels were set at a p-value <0.05.

## RESULTS

At the end of the survey period, data had been collected from 120 individuals [a mixture of both science students (80) and non-science students (40)]. The response rate was 32%. The first section of the questionnaire aimed to compare the distribution pattern of the students' preference toward face-to-face and online learning (Table II). Z-test revealed significant differences in comparing the two distributions between face-to-face and online learning (Z-test = 14.96, p<0.0001). Most respondents (97.5% rated 'like' or 'totally like') preferred face-to-face learning (above the midpoint of the Likert scale). Only 33.3% (rated 'like' or 'totally like') of the respondents were inclined to online learning. Approximately 40% of the respondents took a neutral stand toward online learning.

The second section explored digital engagement and sleeping patterns (Table III). The most striking result from the data was the time spent on digital devices. Time spent on devices was 1.8 times higher during the COVID-19 lockdown than before the COVID-19 lockdown. The difference in total hours of digital engagement was statistically significant (t-test = -18.86, p<0.0001). In addition, the total sleeping hours were 0.6 hours lesser during the COVID-19 lockdown than before the COVID-19 lockdown (t-test = -3.92, p<0.0001).

The frequency table for the digital-related health symptoms during the COVID-19 lockdown is presented in Table IV. All symptoms were reported to turn worse during the pandemic, but only 15 of 21 symptoms were found to be statistically significant in the comparison (Table V).

**Table II: Frequency table of rating for face-to-face and online teaching**

| Rating | Face-to-face | | Online learning | |
|---|---|---|---|---|
| | n | % | n | % |
| Totally Dislike | 0 | 0.0% | 6 | 5% |
| Dislike | 1 | 0.8% | 26 | 21.7% |
| Neutral | 2 | 1.7% | 48 | 40.0% |
| Like | 49 | 40.8% | 36 | 30.0% |
| Totally Like | 68 | 56.7% | 4 | 3.3% |
| Total number | 120 | 100% | 120 | 100% |

**Table III: Statistical analysis summary of digital engagement and sleeping pattern before and during COVID-19 lockdown**

| Scopes of Investigations | Mean & Standard Deviation in hours | | |
|---|---|---|---|
| | Before Lockdown | During Lockdown | Difference[#] |
| Digital engagement | 6.91±4.66 | 12.64±3.23 | 5.73 |
| Sleeping hour | 6.49±1.70 | 5.88±1.32 | 0.61 |

[#] Difference is the calculation of the total hours during COVID-19 lockdown minus total hours before COVID-19 lockdown)

**Table IV: Frequency table of the rating for digital-related health symptoms during COVID-19 lockdown [F- frequency, % - percentages]**

| Digital-related health symptoms | 1 (Never) F (%) | 2 (Rarely) F (%) | 3 (Sometimes) F (%) | 4 (Often) F (%) | 5 (Always) F (%) |
|---|---|---|---|---|---|
| Blurred vision at near distance | 45 (37.5) | 43 (35.8) | 29 (24.2) | 3 (2.5) | 0 (0) |
| Blurred vision at far distance | 37 (30.8) | 45 (37.5) | 22 (18.3) | 10 (8.3) | 6 (5.0) |
| Difficulty or slowness in refocusing my eyes from one distance to another | 33 (27.5) | 42 (35.0) | 31 (25.8) | 11 (9.2) | 3 (2.5) |
| Eye strain | 7 (5.8) | 15 (12.5) | 37 (30.8) | 37 (30.8) | 24 (20.0) |
| Tired eye | 2 (1.7) | 5 (4.2) | 38 (31.7) | 43 (35.8) | 32 (26.7) |
| Dry eye | 5 (4.2) | 5 (4.2) | 39 (32.5) | 41 (34.2) | 30 (25.0) |
| Red eye | 15 (12.5) | 41 (34.2) | 42 (35.0) | 17 (14.2) | 5 (4.2) |
| Watery eye | 12 (10.0) | 42 (35.0) | 44 (36.7) | 16 (13.3) | 6 (5.0) |
| Sand sensation in the eye | 37 (30.8) | 37 (30.8) | 33 (27.5) | 10 (8.3) | 3 (2.5) |
| Itchiness | 21 (17.5) | 37 (30.8) | 41 (34.2) | 17 (14.2) | 4 (3.3) |
| Eye irritation | 30 (25.0) | 42 (35.0) | 34 (28.3) | 10 (8.3) | 4 (3.3) |
| Burning sensation in the eye | 38 (31.7) | 43 (35.8) | 31 (25.8) | 5 (4.2) | 3 (2.5) |
| Sensitivity to bright lights | 23 (19.2) | 36 (30.0) | 38 (31.7) | 15 (12.5) | 8 (6.7) |
| Eye pain | 30 (25.0) | 30 (25.0) | 30 (25.0) | 20 (16.7) | 10 (8.3) |
| Neck pain | 9 ( 7.5) | 14 (11.7) | 44 (36.7) | 31 (25.8) | 22 (18.3) |
| Shoulder pain | 7 (5.8) | 19 (15.8) | 46 (38.3) | 30 (25.0) | 18 (15.0) |
| Upper back pain | 11 (9.2) | 21 (17.5) | 39 (32.5) | 28 (23.3) | 21 (17.5) |
| Lower back pain | 8 (6.7) | 22 (18.3) | 40 (33.3) | 29 (24.2) | 21 (17.5) |
| Fingers pain | 18 (15.0) | 24 (20.0) | 42 (35.0) | 24 (20.0) | 12 (10.0) |
| Hand/ wrist pain | 15 (12.5) | 24 (20.0) | 49 (40.8) | 18 (15.0) | 14 (11.7) |
| Elbow/ forearm pain | 23 (19.2) | 36 (30.0) | 42 (35.0) | 11 (9.2) | 8 (6.7) |

**Table V: Statistical comparison of digital-related health symptoms between before and during COVID-19 lockdown**

| Digital-related health symptoms | Statistical Comparison | |
|---|---|---|
| | Wilcoxon Signed Ranks Test | p-value |
| Blurred vision at near distance | -5.568 | <0.0001* |
| Blurred vision at far distance | -2.377 | 0.017** |
| Difficulty or slowness in refocusing my eyes from one distance to another | -2.034 | 0.042** |
| Eye strain | -5.495 | <0.0001* |
| Tired eye | -7.704 | <0.0001* |
| Dry eye | -7.433 | <0.0001* |
| Red eye | -0.999 | 0.318 |
| Watery eye | -0.323 | 0.747 |
| Sand sensation in the eye | -3.858 | <0.0001* |
| Itchiness | -0.847 | 0.397 |
| Eye irritation | -3.280 | 0.001* |
| Burning sensation in the eye | -4.986 | <0.0001* |
| Sensitivity to bright lights | -0.519 | 0.603 |
| Eye pain | -0.309 | 0.757 |
| Neck pain | -5.502 | <0.0001* |
| Shoulder pain | -5.212 | <0.0001* |
| Upper back pain | -4.948 | <0.0001* |
| Lower back pain | -5.149 | <0.0001* |
| Fingers pain | -2.001 | 0.045** |
| Hand/ wrist pain | -2.427 | 0.0155** |
| Elbow/ forearm pain | -1.376 | 0.169 |

*Significance at p<0.01
**Significance at p<0.05

## DISCUSSION

The impact of online learning on university students was elaborated from three aspects: the acceptance level, the engagement level and the health impact. This study offered insight into the learning preference of the youth that can be useful for the pedagogy decision. The online learning impact was further scrutinized on the digital engagement pattern and health issues. A direct comparison before and during the pandemic was crucial. It might indicate whether digital indulgence was related to online learning or merely a natural transition to the computer era.

Recent studies reported that the readiness for online learning was significantly higher in females than males (10, 32). Similarly, they also found that those who engaged on the Internet for 5 to 6 hours per day were more ready and keen on online learning than those who used it for less than 2 hours per day. The implementation of remote online learning has a lot of constraints and challenges (8,12). Common challenges included lack of motivation, adaptation issues, time management, lack of interaction, and difficulty with lessons. Previous studies provided insights into the perception of the learners and teachers on the implementation of online learning. Hebebci et al. claimed that teachers and students considered online learning an exemplary process (33). Meanwhile, Schlenz et al. argued that online learning was an acceptable choice and alternative during this pandemic (34). However, many students expressed that they did not feel fully ready for the practical part of the curriculum simply by taking part in online learning. A recent study claimed that online learning could not produce the desired results in underdeveloped countries (35). Although the students were mainly ready for online learning, more than half would not want to continue with online learning if given a choice, regardless of gender and program level (36). Our findings were consistent with previous findings. Our respondents expressed an inclination towards face-to-face learning. This finding broadly supported the work of prior studies, which did not seem to agree that online learning was more effective than traditional learning. One possible contributing factor was technical infrastructure limitations and the sense of uncertainty about online learning. Distraction, limited social interaction, complicated technology and difficulty contacting teachers were some disadvantages of online learning, which could affect the student's preference for online learning (37). The acceptance of online learning remained marginal and needed more research to optimize the implementation.

Prolonged usage of digital devices is unavoidable during this unprecedented COVID-19 pandemic and has drastically shifted our pedagogy strategies and perspective of technology in education. Our data on the total sleeping hours and the digital engagement before and during the lockdown indicated that the students had more sleeping hours before the COVID-19 lockdown. Still, as expected, they spent more time on digital engagements during the COVID-19 lockdown than before. These results match those observed in earlier studies during the early phase of the pandemic, which has shown increased Internet usage and digital screen time compared to the time before the pandemic (8–10).

Computer vision syndrome (CVS) is a cluster of symptoms, including eyestrain, headache, blurred vision, dry eyes, and neck and shoulder pain resulting from prolonged usage of electronic devices (38). Individuals engaged in prolonged electronic device usage daily suffer from digital-related health issues, primarily digital eye strains. Our respondents spent more time in digital engagement and reported worsened dry eyes, eye irritation, and sandy and burning sensation in the eyes during the COVID-19 lockdown. Exposure to the electronic screen affects the quantity and quality of blinking, which worsens the dry eye condition (39–41). The incomplete blinking and reduction in the number of eye blinks increase the evaporation of tears. Tired eyes and eye strain are common after focusing intensely on near activity for a prolonged duration. Our respondents also reported worsened eye strain and tired eyes. Blurred vision and focusing difficulties also became more apparent. These may be a sign of prolonged near work related negative

impact on vision.

Postural-related health symptoms such as neck pain, shoulder pain, upper back pain, lower back pain, finger pain, and hand/ wrist pain seemed to get worse during the COVID-19 pandemic lockdown in our findings. Workstation design significantly impacts upper quadrant posture and muscle activities such as head tilt, neck flexion, gaze angle, cervical erector spinal activity and a trend for lower right upper trapezius activity (42,43). Students reported worse finger pain and hand/wrist pain during the COVID-19 lockdown in the present study. The pain may be linked to Carpal tunnel syndrome (CTS), a musculoskeletal disorder often related to prolonged computer use (18,20,44,45). Carpal tunnel syndrome, compression of the median nerve within the carpal tunnel, can arise from repetitive wrist motions (44). Online learning incurs repetitive use of a computer keyboard or mouse. Despite the increasing trend of CTS, much uncertainty about the association between the use of computers and the risk of possible CTS is concerned. Computer use has also been linked to sedentariness. The present study reported neck, shoulder and back pain to get worse during the COVID-19 lockdown. Computer-related muscle and joint problems can be worsened by poor workstation design, unergonomic posture and sitting for long periods. Thus, it hurts the quality of life of the students.

In a nutshell, there are a few preventive care can be adopted by relevant stakeholders (i.e., Ministry of Higher Education, university, students etc.) to manage health related implications from the shift of learning setup. Health tips on digital engagement and self-check on digital-related health symptoms should be introduced to all students in formal platform. Students' welfare should be the priority. The higher education institution might need to balance cost efficiency and practicality.

The effect of online learning on mental health had been raised as concern (36, 46). Remote learning had its implication toward study-life conflicts that had a greater influence on mental health (46). Unfortunately, we did not investigate the mental health component. Another limitation of this study was the small sample size. However, the detailed investigation of the digital engagement and the comprehensive symptomatology list covered by the survey offset the shortcoming.

## CONCLUSION

The education sector has been significantly affected by the COVID-19 pandemic. Educational institutions have rapidly shifted to online platforms. This study revealed that the COVID-19 pandemic has negatively affected students due to the significant increase in usage of electronic devices with reduced sleeping hours during the lockdown. The time spent on digital devices saw nearly a two-fold increase (1.8) during the COVID-19 lockdown compared to before the COVID-19 lockdown. The majority of the digital-related health symptoms worsened during the lockdown. In addition, most of the respondents preferred face-to-face learning to online. This information is crucial for education policymakers to take into consideration when mandating the new norm post-COVID-19.

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