TECHNOLOGY FATIGUE DURING THE COVID-19 PANDEMIC: THE CASE OF DISTANCE PROJECT-BASED LEARNING ENVIRONMENTS

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ABSTRACT

Technology has invaded all spheres of life, including education and providing a lot of facilities. It has played a great role in managing education during the coronavirus disease (COVID-19) crisis. However, technology might prove detrimental if there is too much of it which may negatively affect its users in some way. This study aimed to investigate final-year students' technology fatigue in distance project-based learning environments during the COVID-19 pandemic. The study employed an online survey approach to collect data from 86 final-year students. The results showed that technology does not highly fatigue final-year students in distance project-based learning environments. Still, the study reported some factors that contribute to increasing and decreasing final-year students' technology fatigue level, which may inform project supervisors and decision-makers on the best practice for implementing distance project-based learning without putting students under great pressure and fatigue resulting from technology. This study adds to a limited yet growing body of literature on a very important topic, technology fatigue, that has recently arisen in the academic sector especially during the COVID-19 pandemic, when technology was the quickest and most ideal response to the global lockdown.

Keywords: Distance learning, project-based learning environments, Saudi Arabia, technology fatigue, university students.

INTRODUCTION

Technology is a vital part of human life in the current era. Throughout the day, people use their smartphones to, for example, browse the internet, social network, communicate with work and friends, and read the news. In 2020, with the rapid spread of coronavirus disease (COVID-19) and the subsequent long lockdown, many daily life aspects transferred to virtual realms, including education. Due to the urgent closure of schools and universities, students and instructors were required to stay online for all academic matters, from classes to office hours to graduation ceremonies. This overuse of technology may lead to the feeling of being overloaded and exhausted (Yu et al., 2019), triggering many other implications that encourage researchers to investigate this matter. One implication is technology fatigue, defined as stress caused by technology and frequent changes in technology (Halupa & Bolliger, 2020). The variable of technology fatigue is relatively new in the Saudi education literature and has not yet been researched. This study thus aims to investigate the technology fatigue of final-year students at King Faisal University, Saudi Arabia who worked on projects distantly during the COVID-19 pandemic.

LITERATURE REVIEW

Technology Fatigue

Recently, technology significantly developed to become a crucial part of people's lives that they cannot quit. However, this development has brought a higher incidence of technology stress, overload, and fatigue (Shu et al., 2011; Fitzgerald, 2021). Technology fatigue is the experience of having lots of new technologies being

introduced so quickly that one needs to learn and use them in a limited time, which causes them to feel unable to keep up with them all (Wujcik, 2011). Researchers have reported many reasons for technology fatigue, such as information overload, system features, communication overload, device proliferation, and operating multiple gadgets with multiple functions (Lee et al., 2016; Karr-Wisnewski and Lu, 2010; Grandhi et al., 2005). This fatigue and stress may decrease productivity (Ayyagari, 2012) and negatively affect academic achievements (Sass & Goldring, 2021). It may also lead to physical and psychological strains (Lee et al., 2016) like headaches, stiff shoulders, eyestrain, backaches, difficulty sleeping, and depression (Okonoda et al., 2017).

When the COVID-19 global pandemic first began, educational institutions urgently introduced technology to students, parents, teachers, and employees for instant use in an effort to keep education going but it lasts over a prolonged period of time. The pandemic's social distancing then triggered the extensive use of technology and resulted in many reports of technology fatigue (Williams, 2021). Supporting this claim, Niemi and Kousa (2020) studied students' and teachers' perceptions on distance learning in a Finnish high school during the COVID-19 pandemic and found that overall, the technical problems that students face require using more technical applications than in face-to-face schooling. They also found that students spend much more time on distance learning than they do on face-to-face learning. The students therefore felt highly pressured and were overloaded with tasks and exam deadlines. In addition to the e-learning requirements that force students and teachers to use technology is personal technology use in daily life. Already there is evidence that fatigue and exhaustion caused by excessive social media use alone can decrease student academic performance and disable the effective completion of learning activities (Cao et al., 2018; Yu et al., 2019; Aharony & Zion, 2019; Wang et al., 2020).

On the other hand, there is evidence that the effect of technology fatigue maybe only true for the older generation who was born before the context of the iPhone as the youngers have not been affected by the rapid and urgent shift caused by the COVID-19 pandemic (Golu, 2021). They, the younger, may need longer time, estimated by two years, of full dependence on working distantly (Golu, 2021) using videoconferencing and other technology-based tasks for work in addition to private life technology-based tasks to be affected by technology fatigue (Molino et al., 2020; Palumbo, 2020). There are some factors that can mitigate the fatigue effects of excessive technology activities such as balancing work-life (Golu, 2021). Working hours must be carefully defined. Moreover, a user needs to pay attention to self-care measures, such as having enough breaks to rest while working, mindfulness, relaxation, or meditation exercises (Carissoli et al., 2015; Gaggioli et al., 2019; Linardon et al., 2019; Golu, 2021). In their study that measures the levels of coping with online course (Zoom) fatigue of preservice teachers in the emergency remote teaching process, Bayindir and Gokce (2021) mentioned some actions taken by teachers to mitigate the effect of Zoom fatigue such as resting, exercising, having snacks, and relaxing. Halupa and Bolliger (2020) have explained a number of factors that are believed to mitigate technology fatigue experienced by faculty in higher education, such as administration, support, time to learn, technology-free zones, and responsibility. The authors demonstrated that the administrators should have more reasonable expectations from the faculty and eliminate the need for immediate communication. They moreover expressed the need of having more training opportunities that were effective and timely. They also added that support should be ongoing based on demand and adequate time must be allocated to learn about new technology and platforms. The faculty in Halupa and Bolliger's (2020) study advocated for finding technology-free zones where they take breaks and disconnect, to select user-friendly and stable programs or platforms to work on, and to provide good and simple resources to learn from when required. Finally, the students need to be more responsible for their own learning along with providing them with more guidelines and explanations, tutorials, training, and support.

Scholars have rarely researched the concept of technology fatigue in the educational context. However, some studies have highlighted the fatigue resulting from the extensive use of certain types of technology, such as videoconferencing, especially during the COVID-19 pandemic (Bailenson, 2021; Riva et al., 2021; Toney et al., 2021; Bennett et al., 2021). These articles reported that videoconferencing for long periods during the day seems particularly exhausting and increases fatigue. Other studies have researched social media fatigue (Dhir et al., 2019; Lee et al., 2016; Lee et al., 2014). These studies showed that connecting and communicating via social networks may require increased energy that may lead to diminished enthusiasm and fatigue. Moreover,

researchers have implicitly identified technostress as one of technology fatigue's consequences (Vega-Munoz & Estrada-Munoz, 2020; Penado Abilleira et al., 2021; Wang et al., 2020).

In a more specific context, Halupa (2018) investigated technology fatigue in faculty members. The study claimed that technology is changing rapidly and may cause change fatigue that triggers change resistance in some faculty; the study also distinguished between technology resistance and technology fatigue. Another study, Halupa and Bolliger (2020), examined technology fatigue in higher education faculty in the United States. The authors argued that technology fatigue is a combination of technostress and change fatigue and explored the faculty's perceptions of technology fatigue, as well as compared their fatigue levels based on gender. The study's findings revealed that all the faculty experienced moderate levels of technology fatigue, though male faculty were more fatigued than female faculty.

As revealed from the above literature, technology fatigue has received little attention from scholars in the educational field. Moreover, student technology fatigue specifically remains unexamined. Researchers have already found technology fatigue to have negative consequences on academic outcomes, so it is worth examining students' technology fatigue to ensure their productivity and performance, as well as provide them essential support. This study thus adds to the limited yet growing body of literature on this important topic especially during the COVID-19 pandemic, when technology is the quickest and most ideal response to global school closures.

Distance Project-Based Learning Environments

Project-based learning (PBL) is traditionally defined as a student-centered teaching and learning method that encourages learners to engage in rich learning situations to collaboratively or individually accomplish a certain goal over a period of time (Al Mulhim & Eldokhny, 2020). The literature indicates that PBL is widely used in the education field (Al Mulhim & Eldokhny, 2020; Chen et al., 2019; Holmes & Hwang, 2016; Johnson et al., 2013; Rogers et al., 2011). It also reports that PBL can improve education outcomes, such as attitudes toward learning, motivation, academic achievement, self-assessment, self-directed learning, the learning of higher-order thinking skills, self-regulation skills, research skills, practical thinking, problem-solving skills, creativity, and collaboration (Al Mulhim & Eldokhny, 2020; Ardhyantama et al., 2020; Bilgin et al., 2015; Chen et al., 2019; English & Kitsantas, 2013; Mahasneh & Alwan, 2018; Dilekli, 2020; Wahyuningsih et al., 2021, Edy et al., 2020; Yuliansyah & Ayu, 2021).

Distance project-based learning (DPBL) is very similar to traditional PBL but occurs remotely online, as the project team does not meet face-to-face nor with their supervisor. Educational institutions have broadly applied DPBL during the COVID-19 pandemic (Ardhyantama et al., 2020; Edy et al., 2020; Hira & Anderson, 2021; Kuladinithi et al., 2020; Kartikawati, 2020; Rahayu & Fauzi, 2020; Wahyuningsih et al., 2021; Yuliansyah & Ayu, 2021). However, the DPBL environment has not yet been studied alongside technology fatigue, though there are different arguments about it. From one perspective, the DPBL environment itself can sometimes be stressful and exhausting when the goal is higher than the students' cognitive abilities or if they are accustomed to traditional learning only. DPBL also has many demands that can increase students' and teachers' boredom and stress (Ardhyantama et al., 2020). In such a case, DPBL becomes unmotivating and discouraging, and students may not achieve the anticipated learning outcomes (Dilekli, 2020). As a result, teachers need to prepare and monitor students well in this learning setting to provide necessary support when needed. Teachers also need to create good communication with students to reduce stress levels resulting from out-of-control factors like the internet connection problems (Ardhyantama et al., 2020). All these factors can contribute to more reliance on technology use, which may lead to more fatigue. From another perspective, there is evidence that PBL helps improve students' ability to manage stress and fatigue (Sirotiak & Walters, 2009). Moreover, studies carried out during the pandemic on DPBL have shown that it is an appropriate alternative to traditional face-to-face learning (Ardhyantama et al., 2020; Hira & Anderson, 2021; Yuliansyah & Ayu, 2021; Yustina et al., 2020), especially for practicum knowledge (Edy et al., 2020). Even so, this debate has not yet been resolved, and further investigation is required to give preference to one of these perspectives.

THEORITICAL BACKGROUND

Findings from studies on technology stress agree with the transactional theory of stress and coping by Lazarus and Folkman (1984). According to this theory, psychological stress results from the interaction between the individual and the environment, particularly when the individual's commitments exceed their resources and endanger their well-being. In other words, stress is a transactional process in which stressors interact with an individual's ability to work and achieve their goals, which leads to fatigue as the individual's response to the stressors (Cooper et al., 2001). There are different types of environmental stressors, such as demands, conditions, workload, temporal factors, relationships, the novelty or ambiguity of a situation, and event uncertainty (Lazarus & Folkman, 1984; Lee et al., 2016). Working with technology itself is a major stressor when it overloads individuals and requires them to use it too much, longer, or faster than they can manage, which studies have proven to be fatiguing (Moore, 2000; Karr-Wisniewski & Lu, 2010). In this context, fatigue can take different forms, such as discomfort, dissatisfaction, exhaustion, and negative attitudes toward technology (Lee et al., 2016; Fuglseth & Sorebo, 2014; Salanova et al., 2013). This current study adopts the transactional theory of stress and coping to understand technology fatigue in DPBL environments.

Considering the COVID-19 pandemic, having sudden and immediate changes in academic plans and fully shifting from PBL to DPBL was not easy for some students and their teachers. They could not meet face-to-face again for a long time. Even now, they have to rely on distance learning and online meetings, which are not always clear of disturbances or interruptions and may occur despite the absence of some team members (Kuladinithi et al., 2020). Adding to that, many teachers and students have reported several technology-related obstacles that they faced during the pandemic, such as lack of access to computers and the internet, technical problems, lack of technological competence, and a large assignment load (Kartikawati, 2020; Rahayu & Fauzi, 2020). These burdens only increased and the role of technology enlarged, which creates an evident stressor that may affect learning outcomes. This situation raises this study's main question, which asks how fatigued final-year students who enrolled in a DPBL environment were during the pandemic.

RESEARCH QUESTIONS

- To what extent did final-year university students experience technology fatigue in distance project-based learning environments during the COVID-19 pandemic?
- What factors contributed to final-year university students experiencing increased levels of technology fatigue in distance project-based learning environments?
- What can help final-year university students lower their level of technology fatigue in distance project-based learning environments?

METHOD

Research Approach

The research followed a descriptive survey approach, the most appropriate for the research objective to assess graduating students' technology fatigue as caused by a DPBL environment during the COVID-19 pandemic.

Participants

The study recruited all the final-year students (n = 86), aged 22–24 years old, from the Educational Technology Department at the Faculty of Education, King Faisal University, Saudi Arabia at the end of the last semester of the 2020/2021 school year. The participants enrolled in a mandatory course, the Graduation Project, which had taken place throughout the whole year. They were asked to complete an online survey to assess their levels of technology fatigue resulting from the DPBL environment during the COVID-19 pandemic.

Data Collection

For the purpose of this research, an adapted version of the technology fatigue survey developed by Halupa and Bolliger (2020) was employed to measure the final-year students' technology fatigue levels. The survey consisted of 20 closed-ended items, including 4 reversed items, and 2 open-ended questions. Closed-ended items can easily "generate frequencies of response amenable to statistical treatment and analysis" (Cohen et al., 2007, 321), whereas open-ended questions can "catch the authenticity, richness, depth of response, honesty and candor" (Cohen et al., 2007, 330). The closed-ended items were measured on a 4-point Likert scale (Strongly Agree = 4; Agree = 3; Disagree = 2; Strongly Disagree = 1). These items' highest total score was 80, and the lowest was 20. The open-ended questions asked about the factors that increase and decrease technology fatigue in DPBL environments.

A total of eight experts from the educational technology field evaluated the instrument's validity. The experts recommended rewording some of the closed-ended items. These modifications took place, and the instrument then reached its final form.

Halupa and Bolliger's (2020) original technology fatigue instrument had a reliability of 0.95. The present study survey's reliability was calculated using the test-retest method by administering it to a pilot sample of 15 final-year students. Spearman's coefficient showed a result of 0.92, which indicated a high and significant reliability.

Data Analysis and Results

A total of 86 final-year students (15 males and 71 females) completed the survey. The closed-ended items were analyzed through frequencies, percentages, and descriptive data. Responses to the two open-ended questions were analyzed using open coding to "build a descriptive, multi-dimensional preliminary framework for later analysis" (Khandkar, 2009, 8). The data were then categorized and compared according to any arising themes.

The analysis of the survey data generally showed that the final-year students were moderately fatigued (survey total mean = 2.3 of 4) after using technology in a DPBL environment during the COVID-19 pandemic.

Technology Fatigue Survey

Table 1. Frequencies and Descriptive Data of the Technology Fatigue Survey

No.	Item	Percentages		Descriptive data	
		SA/A	SD/D	M	SD
1	I am tired of learning new educational technologies to implement in my online projects.	10.5	89.5	1.66	0.729
2	It seems as soon as I learn a new educational technology to use in my online projects, it becomes obsolete.	50	50	2.60	0.830
3	It is exhausting and difficult trying to keep up with technology to be able to meet teachers' expectations.	38.4	61.6	2.34	0.835
4	It takes a significant amount of time to meet my teachers' expectations in regard to using educational technology in online projects.	48.8	51.2	2.38	0.883
5	Learning new educational technologies makes me tired and/or frustrated.	11.6	88.4	1.73	0.658
6	Learning new educational technologies takes up too much of my time.	67.4	32.6	2.73	0.832
7	Keeping up with educational technology changes is exhausting.	46.5	53.5	2.33	0.860
8	The advances in educational technology occur so fast it is difficult to keep up with them.	50	50	2.56	0.745
9	I am tired of being expected to use new educational technologies in online projects.	16.3	83.7	1.95	0.718
10	I feel as though my online projects and assignments are never finished due to technology.	51.2	48.8	2.53	1.002

11	Technology makes it difficult for me to take a break from learning and/or online projects.	55.8	44.2	2.62	1.008
12	There are days when I do not want to use technology because I need a break from it.	82.6	17.4	3.26	0.935
13	I have stopped using one or more tools (e.g., social media, listservs, gadgets, etc.) because I am too tired of using technology for my online projects.	52.3	47.7	2.59	1.022
14	It energizes me to spend time learning new technologies to implement in online projects. [R]	11.6	88.4	1.79	0.671
15	Technology has improved my online project efficiency. [R]	4.7	95.3	1.48	0.627
16	I feel "mentally tired" due to the use of technology in online projects.	66.3	33.7	2.73	0.846
17	I feel overwhelmed by technology.	62.8	37.2	2.84	0.893
18	I feel apathetic toward educational technology.	2.3	97.7	1.64	0.529
19	Overall, I like using technology for my online projects. [R]	1.2	98.8	1.53	0.525
20	I learn new technologies very quickly. [R]	25.6	74.4	1.99	0.728

Note: SA = Strongly Agree; A = Agree; SD = Strongly Disagree; D = Disagree; [R] = reversed item

As mentioned earlier in this paper, due to the pandemic, the students were forced to socially distance from their supervisors and peers and continue working on their projects remotely. They worked in a DPBL environment for the first time with new technologies, several requirements, and commitments in a limited time and with little support. According to Lazarus and Folkman's (1984) transactional theory of stress and coping, when the situation is totally new and ambiguous for the students, it would be expected to place more burden and stress on them. In addition, the technology fatigue literature emphasizes how technostress and extensive exposure to technology in some circumstances can increase technology fatigue and negatively influence productivity and academic outcomes (Lee et al., 2016; Karr-Wisnewski and Lu, 2010; Grandhi et al., 2005; Ayyagari, 2012; Sass & Goldring, 2021; Okonoda et al., 2017). Despite these expectations, the survey revealed different results. The only explanation that may illustrate this is that the participants were final-year students in the Educational Technology Department and thus were very familiar with the extensive use of technology and PBL. They all belong to the younger generation who live in a technology-rich context, so they may not find the transformation caused by the pandemic as a hard shift (Golu, 2021) or were in an ambiguous situation (Lazarus & Folkman's (1984). They self-regulated their behaviors and had learned to cope with the new situation to organize and conduct their projects fully online, at which they succeeded.

Table 1 shows that item 12 had the highest mean (M = 3.26; SD = 0.935). Approximately 82.6% of the participants strongly disagreed or disagreed that there were days when they did not want to use technology because they needed to rest. The second highest mean (M = 2.84; SD = 0.893) was for item 17, which indicated that almost 63% of the participants strongly disagreed or disagreed that they felt overwhelmed by technology. Items 6 and 16 had equal means of 2.73; over 67% of the participants strongly agreed or agreed that learning new educational technologies required too much time (SD = 0.832), while about 66% felt "mentally tired" due to their use of technology for their online projects (SD = 0.846).

Meanwhile, the lowest mean (M = 1.48; SD = 0.627) was for item 15. The majority of the participants (95.3%) strongly disagreed or disagreed that technology improved the efficiency of their online projects. The second-lowest mean was for item 19, which revealed that almost all the participants (98.8%) did not like using technology for their online projects (M = 1.53; SD = 0.525). Item 18 had the third-lowest mean (M = 1.64; SD = 0.529) and showed that 97.7% of the participants were interested in educational technology.

Contributing Factors to Technology Fatigue

The survey included an open-ended question to understand the final-year students' perceptions of the factors contributing to technology fatigue in DPBL environments, and 67 students interacted with this question. Although the fatigue survey revealed that the final-year students are not highly fatigued by technology, they shared more than 258 responses and problems that were classified into 9 categories, as shown in Table 2.

Table 2. Frequencies of Factors Contributing to Technology Fatigue

Theme	N
Lack of time and overload	54
Social distancing	52
Self-learning	41
Supervisors	32
Technical problems	28
Extensive use of technology	22
Teamwork	20
Health problems	6
Lack of financial support to buy good-quality software	3

The comments revealed that lack of time and workload pressure from other courses was the main problem that the students suffered from (n = 64). Social distancing resulting from COVID-19 was another factor that negatively affected technology fatigue (n = 63). The participants reported that they lacked face-to-face meetings with the other project team members and could not find consistent times for team members to meet distantly. Moreover, some students stated that they simply did not like working on projects remotely.

The fact that conducting projects requires learning new and advanced programming skills led to challenges especially during the pandemic. The students needed to be more independent and self-taught with little or insufficient support from their supervisors (n = 51). The participants further indicated that supervisors may exaggerate the request for distant projects and do not consider the workload of other courses or time constraints (n = 42).

Technical problems also negatively influenced the participants (n = 38). Many reported that programming software they use is usually heavy and hanging a lot. A high-speed internet connection is also necessary to conduct projects, share documents, and communicate with other team members and supervisors, but such a connection may be not available for many of the students. The students also asserted extensive technology use in daily life, such as e-mails, social media, shopping, learning management systems, and virtual learning, as a vital factor that increases technology fatigue and causes the distant projects to be cumbersome (n = 35).

Similar contributing factors toward technology fatigue to those explained above were consistent findings of several studies in the literature. For example, Williams's (2021) study showed the COVID-19 pandemic's social distancing triggered the extensive use of technology and resulted in many reports of technology fatigue. More specifically, social distancing and working in DPBL are exhausting, stressfull and discouraging when the goal is higher than the students' cognitive abilities or if they are accustomed to traditional learning only (Ardhyantama et al., 2020; Dilekli, 2020). Kuladinithi et al. (2020) asserted that relying on online meetings does not always work, as they may be disturbed or interrupted and some team members may not join. Another study that agrees with this study's findings is the study of Niemi and Kousa (2020) that technical problems and spending much more time on distance learning compared to face-to-face learning made students feel highly pressured and overloaded. Many studies have reported that personal technology use in daily life such as excessive social media use alone can decrease student academic performance and disable the effective completion of learning activities (Cao et al., 2018; Yu et al., 2019; Aharony & Zion, 2019; Wang et al., 2020).

Mitigating Factors to Technology Fatigue

The second open-ended question revealed the factors that might mitigate the participants' technology fatigue. Sixty-six participants responded to this question, and their responses were coded and classified into seven categories: social nearness, time, planning, support, control, rest, and expectations, as illustrated in Table 3.

Table 3. Frequencies of Factors that Mitigate to Technology Fatigue

Theme	N
Social nearness	61
Time	58
Planning	53
Support	43
Control	39
Rest	6
Expectations	4

Almost all the respondents (n = 61) preferred social nearness and believed they needed to meet with the project team and supervisor face-to-face regularly. Fifty-eight respondents asserted they needed more time to learn the new technology software and suggested starting at the beginning of the semester. Moreover, they reported that having the practical part of the graduating project occur solely during the final semester would extremely lower their technology fatigue.

For the planning category, the participants mentioned three problems (n = 53). First, they asserted that the course plan should include all the programs that students may need to learn to complete their distant projects at the beginning of the semester. Second, instructors need to work on developing students' self-learning skills. Third, the project's tasks should be divided equally among team members and encourage their cooperation to complete the project. In total, 43 individuals indicated that they needed more support from their supervisors to accomplish their projects. They also required easy resources to learn new software on their own and sufficient opportunities for training. In turn, 39 respondents thought that daily technology use (e.g., social media use) should be balanced to reduce fatigue from the technology used for online projects. A few individuals advocated for regular rest periods during worktime as well (n = 6). Finally, 4 participants suggested having supervisors lower their expectations for students regarding their use and employment of technology in distant projects to reduce their level of fatigue.

The mitigating factors found in this study have been supported by much literature. The study by Ardhyantama et al. (2020) illustrated that in contrast to social distancing, students who are unfamiliar with distance learning would prefer working face-to-face with their colleagues and teachers. Among the very important mitigating factors reported in this study is allowing adequate time for students to learn new programming skills and software. This finding is supported by the result of Halupa and Bolliger (2020) that indicated that faculty need more time to learn about new technology and platforms presented to them by administrators. Similar to Halupa and Bolliger's (2020) findings, the students of this study also asked for self-learning skills development and should be more accountable for their own learning as well as providing them with easy supportive resources to learn from. The results, furthermore, showed the necessity of balancing the use of social media and other daily technology tasks with learning technology-based tasks. This result agrees with the studies of Golu (2021) and Halupa and Bolliger (2020). Having rest and enough breaks was also supported by the studies of Carissoli et al. (2015), Gaggioli et al. (2019), Linardon et al. (2019), Golu (2021), Bayindir and Gokce (2021), and Halupa and Bolliger (2020). Finally, the result of having supervisors decrease their expectations for students regarding their use and employment of technology in distant projects is consistent with the study of Halupa and Bolliger (2020).

CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

This study investigated final-year students' technology fatigue in DPBL environments during the COVID-19 pandemic. The study's results indicated that the participants were moderately fatigued. The participants also reported some contributing and mitigating factors to their technology fatigue. The greatest contributing factors were lack of time and work overload resulting from other course projects, and social distancing. The best mitigating factors, meanwhile, were social nearness, allowing more time to learn necessary skills to accomplish their projects, and starting the projects earlier.

This study may practically imply that teachers need to train their students to use technology in a good, healthy and balanced manner especially when working remotely to avoid being fatigued. This study can also assist inform project supervisors about the factors that may contribute to student technology fatigue, which may negatively affect their productivity and academic achievements therefore they can eliminate them. It also suggests the most suitable factors to lower that fatigue, especially in a distance learning environment where students are under great pressure such as taking regular breaks from technology, balancing private daily life use of technology with the technology-based learning tasks and seeking proper support whenever required. This may inform instructional designers of technology-rich learning environment about the wellness considerations that need to be followed in order to alleviate the feeling of technology fatigue level and its negative consequences that may apply.

The result of this study is encouraging that the participants were not highly fatigued by technology. However, the sample of this study was all from the new digital generation who are very familiar with technology and use it as a crucial part of their daily lives. This result may be not applied to other older participants who do not consider technology as a part of their daily lives or those who have negative attitudes towards technology. Add to that the study was limited to the final-year students of the Dmepartment of Educational Technology who are very familiar with the extensive exposure to technology so the urgent shift to distance learning was not considered a new or ambiguous situation to them. Moreover, the findings may vary when other types of e-learning environments are used such as blended learning environments and flipped classroom environments. In the future, to enrich the growing body of literature on technology fatigue, a comparison of technology fatigue levels among individuals with different demographic characteristics such as gender, age, and study background is recommended. Another comparison may be conducted between individuals with different cognitive styles. More research on technology fatigue may be done in other e-learning environments such as gamification-based environments, flipped classroom environments, and virtual learning environments.

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