Relationship of Noise Level to the Mental Fatigue Level of Students: A Case Study during Online Classes

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Abstract

This research study tackles the relationship of the noise level to the mental fatigue of the student during online classes. The researchers used survey questionnaires to gather data from the respondents who are students having online classes at home. The objective of the study is to determine if the perceived noise level of students significantly differs in terms of gender, area of study, and duration of the study. This study also intends to determine if noise exposure during online classes has a significant contribution to the mental fatigue of students. The statistical treatments used were descriptive statistics, ANOVA, and correlation. The results of the study revealed that perceived noise level does not significantly differ in terms of gender (p-value=0.804) while the area of study (p-value=0.017) and duration of the study (p-value<0.0001) have significant differences in the perceived noise level of respondents. The result of correlation analysis also revealed that noise exposure during online class has a strong contribution to the mental fatigue of students specifically on dimensions such as sensitivity to noise, fatigue, and concentration having the p-value of 0.000, 0.021, and 0.000 respectively.

Keywords
Noise level, mental fatigue, online class

1. Introduction
Due to the pandemic, most of the community was forced to conduct their work activities online throughout their own homes, which created lots of challenges for everyone. One of these challenges is the execution of their work-related activities in a home setting which generates a lot of distraction that leads to the unproductiveness of workers. Office settings are built to enhance productivity by minimizing the number of distractions in the area, compare with the home setting that is unsuitable to be a place for everyone to work. Due to this circumstance, everyone was affected by this shift, especially the students that require a lot of focus. Since education occurs in a school and face-to-face set-up, the current set-up is somewhat challenging because it is hard to find a perfect place in our own homes that felt the same comfort as we are in school.

Noise has a massive impact on our daily living because it exists in all human activity. It is an unwanted sound that could affect our physical and mental health. Noise is the most common occupational health hazard in the manufacturing and industrial environment. As well as other environments such as schools, malls, highways, and houses. People who are being exposed to different noises may experience fatigue, tiredness, and hearing loss. The major health concerns of many people nowadays especially in the manufacturing and industrial environment. To prevent the following effects and outcomes of noise level exposure the noise level of the area must be minimized and reduced to the right noise levels (Canadian Centre for Occupational Health and Safety, 2019)

According to studies (Khajenasiri, F., et al. 2016), almost 30 million individuals employed in the United States are continuously exposed to high noise levels. Having exposure to this different noise can have various effects depending on the type of occupation and work environment. In daylight, many people are busy doing their different tasks with the noise that surrounds them. A study again shows that noise influences the auditory system, and the reduction of hearing ability and noise affects our cardiovascular system and leads to anger, fatigue, headache, hypertension, and

nervousness. Having a high noise level in a specific area the human error has increased in work-related accidents and leads to a decrease in productivity.

1.1 Objectives

The main objective of this study was to determine if the noise has a relationship to the mental fatigue of a student who is attending their online classes. Specifically, the study aimed to determine what is the noise level of the area of the student who is attending their online classes, how many hours the student attending their online classes, what area in their house they are attending their online classes and lastly what could be the possible sources of noise while they are attending their online classes.

2. Literature Review

According to European Parliament about environmental and public health, environmental noise creates an adverse effect on people's health. It shows that it affects behavior, physical and mental health, cognitive impairment, and even sleep disturbance. They were also able to observe that most cities in the EU were experiencing above 55 dB exposure (Babisch W., 2012). In this sense, we were able to understand how detrimental noise exposure since known unions and organizations of leaders are having concern with this issue. Furthermore, the study also finds that noise gives annoyance to the exposed people, and they stress the disturbance of sleep which leads to daytime sleepiness making the person have unorthodox time productivity (Basner M., et al., 2014).

They also added the possible relationship of noise exposure to the effects in cardiovascular illnesses such as hypertension. Even though the adaptation to the noise exposure and decreases the magnitude of stress over time, it is said that an equal stress level still retains to the person within 3 hours of the exposure. Therefore, stress can affect exposed people longer throughout the day and possibly could affect performance (Tao, Y., et al., 2020). According to the study conducted in Mexico, students during online classes experience 3 environmental factors that could affect their academic performance which are Lighting Temperature and Noise. The study would like to know whether this factor contributes to Academic Performance by conducting surveys and statistical analysis afterward. They Found out that the three factors were able to contribute greatly to the performance of students during an online class. Furthermore, they were also able to rank the three environmental factors about which contributes greater than the other, they found out that the noise level was the greatest contributor to the effect of academic performance of students. They compared to other similar studies and shown that noise is common to the students not only in Mexico since it contributes a higher level of distraction for them than the two factors and given that noise pollution is commonly present in their country (Escobedo, G.H., et.al. 2020).

Since this study was only conducted on students of Mexico, our goal is to reassess this study and modify it to the Philippine setting. According to many studies the noise has huge effects on the learning and performance of students, the result from a study shows that chronic and acute exposure to environmental and classroom noise would have detrimental effects on the learning and performance of students. The study wants to give universities and schools to give careful consideration in the design of the classroom to optimize the environment of teaching and learning. The internal and external layout of the school classrooms is not exposed to a high level of noise which affects the learning and performance of the students (Dockrell, J., & Shield, B., 2008). By measuring the noise level of the school, the data processing has come up with 70.79 dB. Based on the noise mapping that the data processing did the classroom of the school was classified as the noisy zoned and the classroom is in the Red Zone because the measured noise level was in the range of the Red Zone. The exposure of the students and teachers from the noise have brought psychological impact to their health and performance example of these are dizziness, emotional and uncomfortable feeling, disturbances in the teaching of the teacher and lastly the students learning performance. The improvement that was suggested is to reposition the different that might help to reduce the noise in the school and classroom area. (Buchari, & Matondang, N., 2017).

The long exposure of students to noise harms student learning. Somehow the effects on student learning depend on the nature of the activity and sounds. The study also shows that enduring exposure to environmental noise may affect the student's cognitive development. Even though some of the cases reported that has only small effects at first, however in the long run it will affect and accumulate risk factors to the student (Bergström, K., et.al. 2013). Being irritated and distracted was the effect of the noise in our surroundings. The irritation and distraction would come up with an effect on our behavior. The more we are irritated and distracted we cannot learn and perform well in our different tasks. It also found in the study that the perception of noise has a huge impact on performance. The motor

vehicles, construction and welding machines, other activities related to music sounds, and lastly the people movement were affecting the teachers and students' teaching and learning performance in the school. The findings of the researcher are that without the proper use and procedures of using a mobile phone it can contribute to the noise pollution to their school. The researcher finds and suggests that the change of route for the motor vehicles can minimize and reduced the noise that the school experiencing (Nzilano, J.L., 2018).

Noise pollution in schools has a significant effect on children's health and growth. Environmentally safe buildings that promote resource efficiency, indoor air and environmental quality, and noise reduction help educators accomplish their objectives. In reference, the most common health and learning-related noise issue, according to BOHS, is a lack of focus (84%). IGS, OAHS, and ACGS, to name a few–even so, fatigue was cited as the most common health and learning-related noise concern by 60%, 44%, and 66% of respondents, respectively. The fact that most of the schools are situated near main roads and are easily affected by vehicle noise can be linked to the results obtained and their variations. The mean levels measured during this study indoors and outdoors were between 68.3 dBA and 84.7 dBA, depending on the engines' proximity to the lane. Though limited in terms of longer-term exposure dose for surveyed students, the cross-sectional mean noise levels measured in this study are accurate representations. Estimates of acute (if significant or episodic) and/or chronic (constant or intermittent) exposures faced by students and adults employed in secondary schools in this environment.

These estimated exposures have the potential to cause and worsen noise-induced hearing loss, as well as non-auditory health effects. We opted to include WHO's (2000) recommendations in our pilot report. The results of this pilot study appeared to be consistent with those of recently completed European Commission-funded studies, which examined the effects of road traffic and aircraft noise on children's cognition and health, as well as the role of a child's increased sensitivity. Noise levels above 55 dBA were shown to interfere with a child's learning process in studies conducted in developed countries—study children had difficulty filtering out background noise. In addition, background noise and hearing voice, as well as lower reading test scores. As a result, the noise produced by mobile sources on nearby primary roads may be partially or entirely responsible for the various symptoms.

Environmental, wellness, and learning-related measurements were taken in secondary schools as part of our pilot study. Furthermore, the high recorded prevalence of health and learning-related results may be due to the lack of noise control measures and equipment in the four study schools. This research assessed possible noise sensitivity at schools by measuring cross-sectional, shorter-term dBA, or loudness. dBA, on the other hand, correlates well with the human decision. When comparing sounds with different spectral or tonal properties, such as pitch, the measure does not correlate as well with the human judgment of relative noisiness or subjective sound quality. High-frequency sounds may be more dangerous to human ears, and high-frequency, erratic, and impulsive sounds may be more irritating as a result of their nature. Due to COVID-19 disease, online classes are now conducted wherein students attend their class while staying at home. In comparison to the face-to-face classes set up, most students still suffer from different types of noise. There are households located near main highways, exposing students to constant and high levels of noise from vehicular traffic and frequent use. Relative to their proximities to the road both inside and outside of houses, of vehicle horns, from tires during the sudden use of brakes, and so forth.

The school and learning environment must not be overlooked as Nigeria struggles to provide adequate health care to its people. The noise was found to be a factor in this research. Levels were higher than WHO acceptable levels for community learning environments both indoors (classrooms) and outdoors (playgrounds) across schools. Lack of attention and exhaustion was the most recorded health problem possibly linked to acute (large or episodic) and/or chronic (continuous or intermittent) noise exposure in the school setting. Noise in learning environments has been shown to have a significant impact on children's learning ability and overall productivity. When compared to children who learn in a calm atmosphere, they do better academically. As a result, future, more systematic longitudinal research in Nigerian schools with repeated steps across seasons, indoors and outdoors, as well as collaborative efforts by government agencies and education stakeholders for policy formulation and implementation, should be informed by this report. The aim is to encourage improved learning environments for children that are free of excessive environmental noise, as well as to help the environment. Adult employees' morale will increase, as will their well-being (Brown, G.E., et al. 2009).

Students from Science majors of the Pontificia Universidade de Campinas (PUC-Campinas) stated that they considered the university and classrooms to be noisy; they identified themselves as the primary source of the noise, and they reacted to noise by trying to listen. Irritability and difficulty concentrating interfere with schooling, grades,

and health. In obstreperous situations, students request silence, opting to sit in front of the class or studying at home. As a result, students were able to recognize noise as a negative factor in both processes of teaching and learning. With this, they can assess the situation and acknowledge the things that need to be done to achieve and promote learning (Dellati, M.D.A., & Sevilha, E.A.M., 2014).

The literature review has generated a strong foundation over the research study and was able to determine the gaps of this research to the ones cited. Some citations were able to enlighten the effects of noise on a person's health. However, this research would more likely focus on the ergonomic aspect of noise which is about the mental fatigue experienced by the respondents. We also focused on having students as respondents since some of the research cited is conducted in either a work setting or public setting. Furthermore, some studies about students' experience of noise exposure are mostly conducted before the pandemic has occurred. In this study, the researchers will mainly focus on online classes conducted inside their own homes since the majority of the population uses this system if not like all. In this manner, we can determine whether the students in school have a similar experience to the new system that the whole community is in. Most of the related studies found are conducted outside the country (Philippines) which cannot be acceptable in the Philippine setting since it is possible that factors could vary depending on the place that the research is in.

3. Methods

The research study is focused on determining if the noise levels affect the mental fatigue of the students during online classes. The following questions would be asked in the questionnaire: perceived noise level in a specific area where the student attends their online classes, number of hours the student attends their online classes in a day, area in the house they attend online classes, and lastly the possible sources of noise during their online classes. The researchers will be only using online questionnaires to conduct the data gathering that they need to support this study and only college students would be answering the questionnaires.

Based on the literature review some different interventions and concepts determine the relationship of noise to mental fatigue of students. First, the source of noise, it is possible that the source of noise must be determined in this research since it could be the cause of the level of distraction it induces to the student. This was proven to the parliament of EU about the urban noise management, that the source of noise within the cities of EU makes their citizens experience higher noise level which is 55 dB and above. The second intervention of Area, since the majority of students today are conducting an online class in their own homes and the place used for the study is not optimal to be used as a working space since it is not built to be used as a working space. This was seen in the study conducted in Mexico where they measure all environmental factors that students experience during their online class. Third, exposure to the noise source over time, made us realize that exposure to extreme environmental causes may lead to loss of concentration as well, also could prolong the possible effects of the exposure. This was seen in the research of Tao, where people who tend to adapt to long exposure of noise levels tend to retain the same level of stress within the prolonged time of exposure. Lastly, the change in behavior and fatigue level of students, since knowing all the characteristics and the exposure of the students to the noise level, the research synthesizes the possible responses and reactions of students and knows the relationship of mental fatigue level to their exposure to noise. Knowing the interventions of their behavior can help this research identify quantitatively the relationship of noise level to the mental fatigue level of students during an online class. Knowing these concepts could produce a lot of contribution to this research.

4. Data Collection

The ergonomics tool that was used in this study is the noise meter application, this application will measure the noise level of a specific area of study of the respondents. This noise meter application helps in determining if the noise level of an area is low or high. Having the results from the noise meter application could help determine the actual exposure of the respondents to noise level and correlate it with the mental fatigue level of students. The perceived noise level of students was also determined using a survey questionnaire. The students were asked to evaluate the noise level in their area of study during online class based on the following scale: (1) Quiet, (2) Faint, (3) Moderate, and (4) Loud. The next tool that was used is the mental fatigue questionnaire that was adopted from the study of Johansson et al. (2010) and Johansson and Ronnback (2014). The purpose of the questionnaire is to assess specific dimensions or aspects of a person's mental condition concerning noise. This includes sensitivity to noise, fatigue, lack of initiative, mental fatigue, mental recovery, concentration difficulties, memory problem, slowness of thinking, irritability, sensitivity to stress, increased tendency to become emotional, decreased sleep at night, and increased sleep.

Statistical analyses were used such as descriptive statistics, analysis of variance, and correlation. Descriptive statistics were used to measure the mean, standard deviation, and median of the different dimension that affects the mental fatigue of the students during their online classes due to the exposure to different sources of noise. The use of ANOVA helped the researchers to know if there are significant differences in the perceived noise level (quiet, faint, moderate, and loud) based on different factors such as age, area of study, and duration of the study. Lastly, the correlation analysis was utilized to determine which among the mental fatigue dimensions have a significant relationship to the actual noise exposure of students during an online class.

5. Results and Discussion

For the profiling of the respondents of the study, the gender of each respondent's profile was divided into two categories: male and female. The researchers were able to survey 66% male students and 34% female students. As for their ages, there are 14% respondents from 18-19-year-old students and 86% respondents from 20-21-year-old students. Moreover, students who attend their class within the range of 1-3 hours were 16% of the respondents, 4-6 hours duration were 38% respondents, 7-9 length of class hours 36% respondents, and students who are in 10-13 class hours were 10% respondents. 70% of the students attend their class in their bedroom, 22% in the living room, and 8% in other parts of their home. For the perceived noise during online class, 10% of students reported that they have a quiet environment, 34% of students have a faint environment, 46% moderate, and 10% loud environment. Finally, for noise exposure level, 20% of the respondents reported being exposed to 50 dBA and below, 60% were exposed to 51-82 dBA, and 20% were exposed to 83 dBA and above.

5.1. Sources of Noise

The researchers have gathered different sources of noise that cause mental fatigue and distraction to the students during online classes. Figure 1 below shows the summary sources of noise and the number of respondents per source of the noise. The data shows the source of noise from pets up to construction/renovation is the major cause of the noise that bothers the students during their online classes.
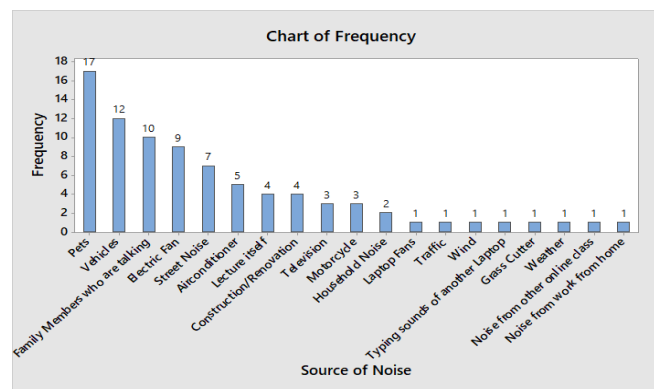

Figure 1. Sources of Noise during Online Class

Based on the 80% cumulative percentage, most of the sources of noise can be managed by moving to a place away from these sources such as pet sounds and chattering voices in the household. However, some of the sources cannot be controlled such as construction works, noises coming from appliances such as air-condition units and Electric Fans, and even noises on the streets. The remaining 20% are not constant noise that could contribute greatly to the noise level. For instance, televisions, laptop fans, grass cutter, does not create a constant noise that could contribute greatly, and these noises can also be diminished with control such as lowering volumes or removing those items to reduce noise.

5.2. Mental Fatigue Survey Result

Based on the data gathered as shown in Figure 2, 27% of the respondents stated that they are not more emotional than they used to be, and they do not sleep more than usual (MFS = 0). 34% of the respondents imply that they sometimes lose concentration when exposed to noise (MFS = 1). 11% of the respondents stated their poor memory causes frequent problems like forgetting important meetings and others (MFS = 2). 4% of the respondents choose the option that they

do not sleep longer or deeper. In brief, Increased tendency to become emotional, Increased sleep, Concentration difficulties, and Memory Problem are the dimensions that have the highest percentage for each mental fatigue score.

However, the dimensions with the highest mean are Concentration difficulties and Irritability. It means that these two dimensions are what the students highly experienced when they hear various sounds of noise that could distract them during their online class. Having difficulties in concentration can lead to various reasons such as personal problems, stress, and exhaustion. According to the study of noise exposure on cognitive performance and brain activity patterns, cognitive functions reduce when noise level exposure is at 95 dB level and above. Which explains why concentration difficulties are the highest dimension among all the other mental fatigue dimension.
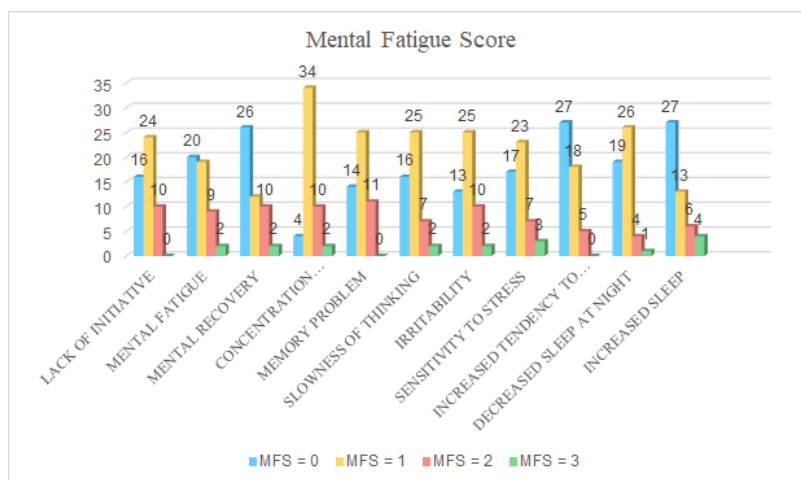

Figure 2. Summary of Mental Fatigue Scores

5.3. Result of ANOVA

One-Way ANOVA was used to determine the significant difference in the perceived noise level of students (quiet, faint, moderate, loud) based on the following factors: gender (male and female), area of study (bedroom, living room, others), and duration of the study (6 hrs and below and 7 hrs and above). The following are the hypotheses of the study:

Ho: There is no significant difference in the perceived noise level based on gender
Ha: There is a significant difference in the perceived noise level based on gender
Ho: There is no significant difference in the perceived noise level based on the area of study
Ha: There is a significant difference in the perceived noise level based on the area of study
Ho: There is no significant difference in the perceived noise level based on the duration of the study
Ha: There is a significant difference in the perceived noise level based on the duration of the study

Table 1. Summary of ANOVA Result

Factors	Variable	Mean	Std. Dev.	p-value	Remarks
Gender	Male	2.330	0.724	0.804	not significant
	Female	2.400	0.737		
Area of study	Bedroom	2.200	0.561	0.017	significant
	Living Room	2.733	0.594		
Duration of study	6 hrs. and below	2.200	0.561	0.000	significant
	7 hrs. and above	3.000	0.535		

Based on Table 1, the area of study and duration of study have a significant difference in terms of the perceived noise level of respondents while gender has no significant difference. For the area of study, based on the interval plot, the perceived noise level of respondents who are studying in the bedroom is moderately lower compared to the living room as shown in Figure 2 (a). This can be explained that respondents perceived having a lower noise level in the

bedroom since this area is more confined and private compare to the living area were mostly used by other members of the household and higher foot traffic.
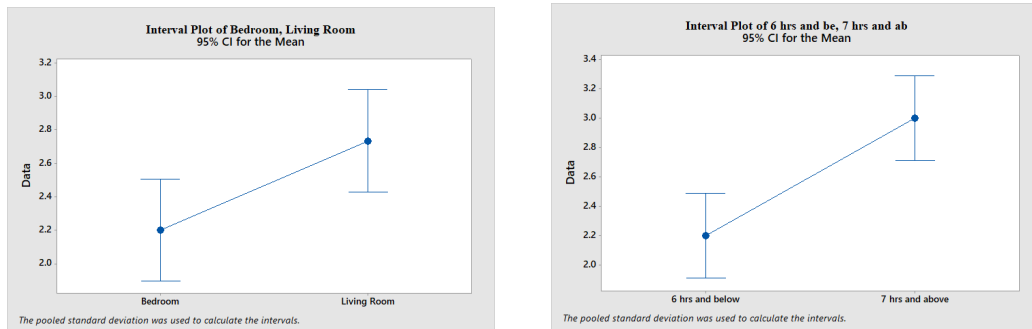

Figure 2. Interval Plot of Perceived Noise based on Area of Study (a) and Duration of Study (b)

For the duration of the study, the interval plot in Figure 2 (b) shows that students who study for more than 7 hours a day have perceived to have higher noise levels compared to students who study for 6 hours and below. The impact of noise adds up over time. According to the National Institute of Health (NIH), if we are exposed to loud sounds regularly, our risk for permanent damage increases over time. Even a single but long-lasting loud event can cause damage. Sound levels below 70 dBA are usually considered safe, even if they last for a long time. However, noises above 70 dBA are more likely to damage our hearing.

5.3. Result of Correlation Analysis

Correlation analysis was utilized in the study to get the relationship between measured noise level exposure and mental fatigue scores of students measured in several dimensions, namely sensitivity to noise, fatigue, lack of initiative, mental fatigue, mental recovery, concentration difficulties, memory problem, slowness of thinking, irritability, sensitivity to stress, increased tendency to become emotional, decreased sleep at night and increased sleep. Table 2 shows the summary of the correlation result between the variables. The null and alternative hypothesis are the following:

        Ho: There is no correlation between noise level and mental fatigue score of respondents
        Ha: There is a correlation between noise level and mental fatigue of respondents.

Table 2. Result of Correlation Analysis

Factors	Pearson (r) value	p-value	Remarks
Sensitivity to noise	0.839	0.000	significant
Fatigue	0.326	0.021	significant
Lack of initiative	0.203	0.158	not significant
Mental fatigue	0.208	0.148	not significant
Mental recovery	0.156	0.280	not significant
Concentration difficulties	0.870	0.000	significant
Memory problem	0.158	0.273	not significant
Slowness of thinking	0.335	0.017	significant
Irritability	0.919	0.000	significant
Sensitivity to stress	0.348	0.013	significant
Increased tendency to become emotional	0.427	0.002	significant
Decreased sleep at night	0.345	0.014	significant
Increased sleep	0.208	0.147	not significant

Based on the obtained Pearson correlation value as shown in Table 2, there is 8 dimension of mental fatigue scores that have a significant correlation between noise levels, these are sensitivity to noise, fatigue, concentration difficulties,

slowness of thinking, irritability, sensitivity to stress, increased tendency to become emotional, and decreased sleep at night, having p-value less than 0.05. Shown also is the Pearson correlation (r) value which measures the strength of the relationship between the dimensions of mental fatigue score to the exposure to the noise level. Based on the result, irritability, sensitivity to noise, and concentration difficulties have a strong correlation to noise level (p-value<0.001). This means that as the exposure to a noise level of students increases, irritability, sensitivity to noise, and concentration difficulties of students also increases. However, the fatigue level, slowness of thinking, sensitivity to stress, increase tendency to become emotional, and decreased sleep at night have only a moderate correlation to exposure of noise level (p-value<0.05).

6. Conclusion

Due to the pandemic, most of the community was forced to conduct their work activities online throughout their own homes, which created lots of challenges for everyone. One of these challenges is the execution of their work-related activities in a home setting which generates a lot of distraction that leads to mental fatigue and stress. One of the causes of distraction is exposure to the noise level. Noise during online class can be caused by a dog barking, car horn, TV playing in the room, people chatting nearby, and other sources. Thus, this study was done to determine the effect of noise level on the mental fatigue of students during an online class.

The results of the study have revealed that the perceived noise level of students significantly differs in terms of area of study and duration of the study. It was found that students who conduct online classes in the bedroom have perceived to have lower noise levels compared to students who are studying in the living room. It was also proved that students who study for more than 7 hours a day have perceived to have higher noise levels compared to students who study for 6 hours and below. In this study, we were able to measure the mental fatigue of students concerning exposure to noise during online classes. We were able to correlate the effects of noise exposure to the specific dimension of the mental fatigue level of students. We have found that exposure to noise level could result in an increase in irritability, sensitivity to noise, and concentration difficulties of students.

With these findings, it is recommended that students who are studying online at home should use noise-canceling headphones to minimize noise exposure from the background. It is also advised for students to have a few minutes break time in the middle of the class for them to take a rest for a couple of minutes and decrease their fatigue and exhaustion. And lastly, students should have a conducive space for learning such as the specific area in the house dedicated for an online class that is away from the noise and has an ambient atmosphere.

References

Babisch, W., et al. (2014). Auditory and non-auditory effects of noise on health. The Lancet, 383(9925), 13251332. Retrieved from: https://doi.org/10.1016/s0140-6736(13)61613-x

Babisch, W. (2012). Exposure to environmental noise: risks for health and the environment. Workshop on "sound level of motor vehicles", Directorate General for Internal Policies of the European Parliament, Brussels. Retrieved from: http://www.europarl.europa.eu/ document/activities/cont/201205/20120524ATT45762/ 20120524ATT45762EN.pdf

Bergström, K., et.al. (2013) Does noise affect learning? A short review on noise effects on cognitive performance in children. Retrieved from: https://www.frontiersin.org/articles/10.3389/fpsyg.2013.00578/full

Brown, G.E., et al. (2009). Assessment of Noise and Associated Health Impacts at Selected Secondary Schools in Ibadan, Nigeria. Retrieved from: https://www.hindawi.com/journals/jeph/2009/739502/

Brown, A.L., & Kamp, I.V., (2015). A Conceptual Model of Environmental Noise Interventions and Human Health Effects. Retrieved from: https://research-repository.griffith.edu.au/bitstream/handle/10072/125260/Brown

Buchari & Matondang, M., (2017). The impact of noise level on students' learning performance at state elementary school in Medan. Retrieved from: https://aip.scitation.org/doi/pdf/10.1063/1.4985498

Canadian Centre for Occupational Health and Safety, (2019). Noise Basic Information. Retrieved from: https://www.ccohs.ca/oshanswers/phys_agents/noise_basic.html

Chai, Y., et.al. (2020). Understanding noise exposure, noise annoyance, and psychological stress: Incorporating individual mobility and the temporality of the exposure-effect relationship. Applied Geography, 125, 102283. doi:10.1016/j.apgeog.2020.102283. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S014362282030196X

Dellati, M.D.A., & Sevilha, E.A.M., (2014). College students' perception of classroom noise and its consequences on learning quality. Retrieved from: https://www.scielo.br/scielo.php?pid=S2317-64312014000200138

Dockrell, J. & Shield, B., (2008). The effects of classroom and environmental noise on children's academic performance. Retrieved from: http://www.icben.org/2008/PDFs/Shield_Dockrell.pdf

Escobedo, G.H., et.al. (2020). The Impact of Environmental Factors on Academic Performance of University Students Taking Online Classes during the COVID-19 Pandemic in Mexico. Retrieved from: https://www.mdpi.com/2071-1050/12/21/9194

Johansson, B. Starmark, A., Berglund, P., Rodholm, M., Ronnback, L. (2010). A self assessment questionnaire for mantal fatigue and related symptoms after neurological disorders and injuries. Brain Inj. 24:2-12.

Johansson, B., Ronnback, L. (2014). Evaluation of the mental fatigue scale and its relation to cognitive and emotional functioning after traumatic brain injury or stroke. International Journal of Physical Medicine and Rehabilitaion. 2:1 DOI: 10.4172/2329-9096.1000182

Khajenasiri, F., et al. (2016). The Effect of Exposure to High Noise Levels on the Performance and Rate of Error in Manual Activities. Retrieved from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4844473/

Nzilano, J.L., (2018). Effects of Noise Pollution on Students Learning in Selected Urban Public Secondary School in Dares Salaam City, Tanzania. Retrieved from: http://arjess.org/effects-of-noise-pollution-on-students-learning-in-selected-urban-public-secondary-schools-in-dar-es-salaam-city-tanzania/

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