Analysis of Mental Workload and Fatigue Level in Online Learning during the Pandemic among Industrial Engineering Students (A Case Study at Buana Perjuangan University of Karawang)

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Abstract. Adjustments in online learning systems during the COVID-19 pandemic have led to an increase in mental workload and fatigue levels among students. This study aims to determine the influence of independent factors and the relationship between mental workload and fatigue levels among Industrial Engineering students during online learning. The research methods used were NASA-TLX and SOFI. The results show a significant influence of marital status on the level of mental workload with a p-value of 0.016, while there is no significant influence of student status and gender with p-values of 0.435 and 0.210. However, there is a significant influence of student status and gender on fatigue level with p-values of 0.008 and 0.000, while marital status has a significant influence with a p-value of 0.326. The correlation test results show that in the NASA-TLX method, 6 pairs of elements have a significant relationship with a p-value of 0.000, while the remaining 8 pairs of elements do not have a significant relationship with p > 0.05. Furthermore, the SOFI method shows all elements have a significant relationship with a p-value of 0.000. The findings of this study can serve as evaluation for institutions to create effective and successful online learning.

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1 Introduction

The pandemic first emerged in Indonesia in March 2020. To this day, COVID-19 remains a significant issue that impacts the education system in the country. Face-to-face education in Indonesia has shifted to online learning due to the implementation of Large-Scale Social Restrictions (PSBB) policies. The government took this measure to control the increasing spread of COVID-19.

As of March 18, 2020, 276 public and private universities in Indonesia implemented online learning. Online learning is considered the best solution for teaching and learning activities during the COVID-19 pandemic to ensure the continuity of academic processes [1]. However, online learning presents challenges and issues such as difficulties for students in understanding the learning materials, varying technological skills, and diverse economic backgrounds of students [1].

According to the complaints received by the Indonesian Child Protection Commission (2020) regarding the new learning system policies, there were 213 complaints received from March 16 to April 9, 2020. 70% of the complainants expressed concerns about the short deadlines for assignments given by schools. At the university level, students expressed similar complaints through news media and social media platforms [2].

According to the Center for Public Mental Health (2021), various problems have emerged during this pandemic. One of these issues is the increase in mental workload and fatigue levels, which can lead to stress among students. The emergence of these psychological problems is attributed to factors such as heavy academic workloads, inadequate learning environments, limited understanding of course materials, lack of social interaction, unstable internet connections, online learning fatigue, and the inability to engage in regular activities [3].

The research conducted by Yikealo [4] showed that most students at the Eritrea Institute of Technology experienced moderate stress at a rate of 71%, with one of the contributing factors being excessive tasks and academic workload at 23.5%. Another study [4] revealed that the highest level of anxiety among students was mild anxiety experienced by 79 out of 101 students, accounting for 41.58%, while the remaining 32 students experienced moderate anxiety, amounting to 16.84%.

Considering the identified issues, it is important to conduct this study with the aim of measuring the mental workload and fatigue levels resulting from online learning among students in different employment-marital status categories, as well as among male and female students. Two methods are used in this study: the National Aeronautics and Space Administration Task Load Index (NASA-TLX) for measuring mental workload and the Swedish Occupational Fatigue Inventory (SOFI) for measuring fatigue levels. The significance of this research lies in generating information regarding the mental workload and fatigue experienced by students, which can serve as a basis for evaluation and provide recommendations for improving the effectiveness of online learning system policies.
2 Method

2.1 Participants

The participants in this study are active students engaged in online learning. The research specifically includes students from the Industrial Engineering Program at Buana Perjuangan University in Karawang, who are from the cohorts of 2018 to 2021, with a total population of 1,214 individuals. The sample size was determined using the Slovin formula (1960), resulting in a sample of 301 participants. The age range of the participating students is between 18 and 37 years (mean = 22, stdev = 2.45). The research was conducted from March 15, 2022, to April 5, 2022, at Buana Perjuangan University, specifically within the Industrial Engineering Program, for the cohorts of 2018-2021, using a Google Form.

2.2 Instruments

The measurement of mental workload utilized the NASA-TLX (National Aeronautics and Space Administration Task Load Index) questionnaire. This method generally consists of five elements: mental demand, physical demand, temporal demand, performance level, and effort and frustration levels. For measuring fatigue levels, the Swedish Occupational Fatigue Index (SOFI) questionnaire was employed. This method includes five dimensions: sleepiness, physical discomfort, lack of motivation, lack of energy, and physical activities.

2.3 Analysis

This study employed two statistical tests: One-Way ANOVA and Pearson's correlation test, conducted using the SPSS software. The variables in this study consist of two categories: independent variables and dependent variables. The independent variables include three factors: student status (X1), marital status (X2), and gender (X3). The dependent variables comprise two factors: mental workload level (Y1) and fatigue level (Y2).

3 Results

3.1 NASA-TLX Method

The calculation of the average weight workload (WWL) scores in Figure 1 shows that students who are not employed have higher scores in mental workload compared to students who are employed. Students who are unmarried have higher scores in mental workload compared to married students. Additionally, female students have higher scores in mental workload compared to male students. Based on the academic year, the mental workload scores for the 2020 cohort are higher compared to the cohorts of 2018, 2019, and 2021.
3.2 SOFI Method

The calculation of fatigue levels depicted in Figure 2 indicates that working students have higher levels of fatigue compared to non-working students. Married students have higher levels of fatigue compared to unmarried students. Moreover, female students exhibit higher levels of fatigue compared to male students. Based on the academic year, the fatigue levels for the 2018 cohort have higher average scores compared to the cohorts of 2019, 2020, and 2021.
3.3 Factors Affecting Mental Workload and Fatigue Levels (p-value = 0.05)

Based on the One-Way ANOVA test results, it was found that p-value = 0.435, where p > 0.05, which means that H0 is accepted and H1 is rejected, indicating that there is no influence between working and non-working status on the level of mental workload. Regarding the influence of student status on fatigue levels, it was found that p-value = 0.008, where p < 0.05, which means that H0 is rejected and H1 is accepted, indicating that there is an influence between working and non-working status on fatigue levels. The influence of marital status on mental workload was found to have a p-value = 0.016, where p < 0.05, which means that H0 is rejected and H1 is accepted, indicating that there is an influence between married and unmarried status on the level of mental workload. However, the influence of marital status on fatigue levels was found to have a p-value = 0.326, where p > 0.05, which means that H0 is accepted and H1 is rejected, indicating that there is no influence between married and unmarried status on fatigue levels. Furthermore, the influence of gender on mental workload was found to have a p-value = 0.210, where p > 0.05, which means that H0 is accepted and H1 is rejected, indicating that there is no influence between gender (male and female) on the level of mental workload. As for the influence of gender on fatigue levels, it was found to have a p-value = 0.000, where p < 0.05, which means that H0 is rejected and H1 is accepted, indicating that there is an influence between gender (male and female) on fatigue levels.

3.4 Relationship Between NASA-TLX and SOFI Elements (p-value = 0.05)

Based on the correlation test results, it was found that some of the relationships between NASA-TLX elements are significant. The highest relationship among the elements is between physical demand and frustration level (p-value = 0.002). The relationships between elements in SOFI resulted in significant relationships for all elements (p-value = 0.000).

4 Discussion

Based on the research results, it is known that the highest element value in the average product value is the time demand element, which is 178.76. This research is in line with the study conducted by [5], stating that the most dominant workload element is time demand. The high value of time demand is caused by the short task collection period compared to the number of tasks that need to be completed. On the other hand, the element with the lowest
average product value is the physical demand element, which is 128.80. This research result is consistent with the study conducted by Yudhistira et al. [6], which found that the physical demand indicator of 505 is the lowest among other indicators.

Regarding the NASA-TLX scores based on student status, the mental workload level for non-working students (62.12) is not higher than that of working students (60.65). The high score for non-working students is attributed to the emergence of fatigue in online learning. Based on marital status, it is found that the average mental workload score for unmarried students (61.77) is higher than that of married students (49.79). In terms of gender, females have the highest average score (63.93) compared to males (60.8). Similar results were obtained in a study conducted by [2] which showed that the NASA-TLX score for females (75.46) was higher than that for males (74.01). This is because the mental instability of females can be caused by Premenstrual Syndrome (PMS), where a woman experiences several changes in the body, emotions (mood), and behavior before menstruation, which can disrupt daily activities [7].

Based on the academic year, the highest average score for mental workload is found in students of the 2020 academic year (65.14), while the lowest is in students of the 2019 academic year (56.97). The high score for the 2020 cohort is due to the number of credit units (minimum of 21 credits) taken in the second year of study compared to the number of credits (minimum of 18 credits) taken in the first year. Lack of understanding of the material delivered due to an unfavorable environment or disrupted internet connection also contributes to the high score of mental workloads experienced by students of the 2020 cohort. Mardiana et al. [8] stated that limited understanding of the material, an unfavorable learning environment, and an unstable internet connection can cause an increase in the mental workload of students.

The research results using the SOFI method reveal that the highest fatigue level is experienced by working students (5.16), while non-working students experience the lowest fatigue level (4.61). These research findings are consistent with those conducted by Ningsih and Nilamsari [9], which showed that workers with light workload have low fatigue levels, while workers with heavy workload have moderate fatigue levels. Based on marital status, it is known that the highest fatigue level is experienced by married students (4.92), while the lowest is experienced by students who are not yet working (4.39). Similar results were obtained from a study by Agustin and Sariah [10], where the highest fatigue level was found among married respondents, accounting for 76.7%.

Furthermore, the research results based on gender indicate that the highest fatigue level is experienced by female students (5.86), while male students have the lowest fatigue level (4.71). These research findings are consistent with a study conducted by Susanto and Azwar (2020), which found that the average SOFI score for females (3.07) is higher than that for males (3.06). Based on the academic year, it is known that the highest fatigue level is experienced by students of the 2018 cohort (5.40), while the lowest is experienced by students of the 2021 cohort (4.38). The high average score for students of the 2018 cohort is due to the final project, which involves considerable time and effort in completing the report. Final-year students generally stay up late to meet the graduation deadline, and this is related to the research findings by Agustina [11], where fatigue is caused by inadequate sleep and rest.

The influence of student status on fatigue level reveals a p-value of 0.008, where p < 0.05, indicating that H0 is rejected and H1 is accepted, or there is an influence between working and non-working status on fatigue level. A study conducted by Delima [12] showed that
workload variables have an influence on work fatigue, where a higher workload assigned by the company increases employee fatigue.

Regarding the influence of marital status on mental workload level, a p-value of 0.016 is obtained, where p < 0.05, indicating that H0 is rejected and H1 is accepted, or there is an influence between married and unmarried status on mental workload level. In a study conducted by Suci [13], it is stated that one of the factors affecting the level of mental workload in marital status is responsibility.

The highest correlation between elements in the NASA-TLX method is found between the physical demand element and frustration level (p-value = 0.002). This contradicts the study conducted by Braarud [14], where the highest correlation between elements is between the mental demand element and effort demand element. The relationship between elements in the SOFI method shows significant correlations for all elements (p-value = 0.000). This research result is consistent with a study conducted by Gutierrez et al. [15], which found significant correlations among all elements in the SOFI method.

5 References


