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Effects of workload on academic performance among working students in an undergraduate engineering program

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Abstract

In the Philippines, the supply of engineering graduates produced per year is lower than the demand as local industries are becoming engineering-related. This poses a challenge to academic institutions to fill this gap. Assessment reveals low graduation rate in the Engineering programs in the Philippines, where approximately 35.4% of the students are working at the same time. With the aim to help these students prevent possible retakes, the proponents explored and analyzed the effects of workload on academic performance and the factors associated with it. NASA Task Load Index (NASA-TLX) was utilized to measure students' workload in this study. Recommendation presented in this research are interventions to support physical and mental health to better cope in a high workload environment, which will in return translate to better work and academic performance thus an increase in graduation rate.

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Keywords: Ergonomics; Workload; Academic performance; NASA-TLX

1. Introduction

In the Philippines, there are a total of 2,313 colleges and universities accredited by CHED (Commission on Higher Education) and out of these academic institutions, a total of 345 schools are offering engineering programs. In 1,901,918 enrolments in the priority disciplines in the year 2012 to 2013 with engineering and technology having

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406,831 enrolments only 59,399 students completes the course and graduates. According to a report from CHED tackling supply and demand of higher education graduates, Engineering was the only cluster with a negative rate of flow to the labor market [1]. This poses a challenge to academic institutions to fill this gap. Academic institutions must address this issue through implementation of strategies that would help facilitate students' optimum learning. To realize this goal, key indicators that schools must monitor are the students' academic performance and the number of graduates produced each year. Contributing factors (i.e. workload) to student's well-being are also important to explore because these directly and indirectly affect performance.

Assessment reveals that most retakes are observed with working students and therefore need attention from the academic institution. This study aims to investigate the effect of overall workload to academic performance of working engineering students as basis of strategies that may help the students better adapt in situations requiring high workload.

The results of this study will help educators and administrators of academic institutions provide better learning environment for engineering students in the country. This research can serve as a basis in the creation of instructional content, course design, and physical characteristics of instructional materials and as well as advised unit load suitable for working engineering students. By understanding the relationship of workload and academic performance, concepts of physical and cognitive ergonomics can help educators assess, plan, design and implement measures to support students.

2. Literature review

Workload components are the key tasks characteristics influencing human performance which define how people accomplish a required work and in what manner a person comprehends the task [2]. Task demand is the ratio between time needed to complete a certain task and the available time to satisfy it and pointed out that workload is a combination between the available resources of an operating system, task demand, and people's capability [3].

Workload influences and decreases the capacity of an individual. A rise in the task demand level may prompt errors and an increment in accordance to response time [4]. In addition, high-task workload and complexity are thought to be two of the most critical factors in the reduction of performance quality [5].

Primary task performance measures measure the performance end result of the task. On the contrary, secondary performance measures evaluate the residual resources or capacity not used in the primary task. Subjective procedures involve rating scales that users answer to assess the subjective effort needed to perform a task. The widely and, most commonly used subjective measuring scales include the Cooper-Harper Scale [6], NASA-Task Load Index (NASA-TLX) [7] and [8], and the Subjective Workload Assessment Technique (SWAT) [9].

The aspects considered in this study include over all workload, academic performance, unit load, age, sex, type of work (part-time or full-time), health status, lifestyle and current year standing of the students. Variables other than what is specified were not being treated in this study.

3. Research design and methodology

Descriptive research design was used to undertake this study. Participants of this study are non-working and working (full-time and part-time) engineering students of an academic institution in Metro Manila, Philippines.

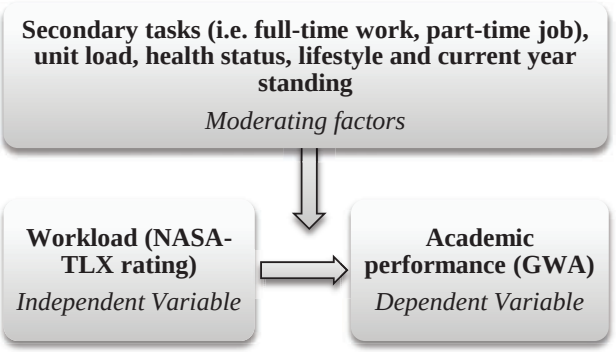

Fig. 1. Conceptual Framework.

3.1. Conceptual framework

Figure 1 shows the conceptual framework that describes the study.

3.2. Methodology

A survey questionnaire was devised to collect demographic data, academic performance through general weighted average (GWA), unit load, secondary tasks (i.e. full-time work, part-time jobs, etc.), health condition and lifestyle. In measuring human overall workload, the Paper and Pencil Package of NASA Task Load Index (NASA-TLX). The NASA-TLX is a subjective, multidimensional assessment tool that rates perceived workload, in order to assess a task, system, or team's effectiveness or other aspects of performance. The Human Performance Group at NASA's Ames Research Center developed it over a three year development cycle that included more than 40 laboratory simulations. After completing the survey questionnaire, the participants were asked to answer the NASA Task Load Rating sheet to measure their workload.

In treating the data needed to answer the research questions, MINITAB Statistical Software was used to calculate necessary parameters. Descriptive statistics such as means and standard deviation of responses were used to illustrate trends in the population and characteristics of the variables. The Pearson Product-Moment Correlation Coefficient, t-test and unpaired t-test were used to for testing all hypothesis presented in this study.

4. Results and discussion

In this section, the results of the data gathered are presented and discussed.

Table 1. Descriptive Analysis of Students' Demographic and Lifestyle Data.

Demographics	Frequency	Percentage
Gender		
Male	13	57
Female	10	43
Age		
18-20 y/o	6	26
21-23 y/o	9	39
24-26 y/o	7	31
27-29 y/o	-	-
30-32 y/o	1	4

Lifestyle	Frequency	Percentage
Type of Work		
Full-time	5	22
Part-time	18	78
Daily physical activity		
Extremely inactive	-	-
Sedentary	9	39
Moderately active	14	61
Vigorously active	-	-
Extremely active	-	-
Average Sleep		
0-2 hours/day	-	-
3-5 hours/day	18	78
6-8 hours/day	4	18
>9 hours/day	1	4
Smoking		
Yes	3	13
No	20	87
Drinking Alcohol		
Yes	16	70
No	7	30
Health (BMI) – WHO		
Underweight	2	9
Normal Range	6	26
Overweight	14	61
Obese	1	4
Academic Unit Load		
1-7 units (low)	5	22
8-14 units (medium)	10	43
15-21 units (high-full)	8	35

Table 2. Descriptive Analysis Showing Students' Mean and Standard Deviation on Age, Average Sleep, BMI and Academic Load.

Variables	Frequency	Mean (μ)	Standard Deviation (σ)
Age	23	22.5	3.2
Hours of sleep	23	5.7	1.2
Academic unit load	23	13	2.7
BMI	23	25.2	5.0

Working Engineering students participated in the study comprises 22% full-time workers and 78% part-time workers. Students' academic unit load shows that most of them had 8-14 units last semester. Majority of the respondents belongs to the 21-23 years old age bracket. Moreover, Table 1 reflects their lifestyle and health. In their daily physical activity, 61% reported being moderately active as they have work to attend to. Average sleep of the students ranges from 3 to 5 hours per day. Lifestyle parameters show that 87% of the students do not smoke while

70% drink alcohol. BMI was also included as it reflects overall health status of a person. Most students fall in the overweight category at 61%.

Table 3. Descriptive Statistics and Correlational Analysis of General Weighted Average (GWA) and NASA-TLX Ratings.

Variable	Frequency	Mean (μ)	Standard Deviation (σ)	df	Correlation Coefficient (r)	Critical r	Decision
GWA	23	81.73	4.67	21	0.58	±0.413	Reject Ho
NASA-TLX	23	65.77	17.73				

*P ≤ 0.05 P value = 0.003

Table 4. Descriptive Statistics and T-test of General Weighted Average (GWA): Working and Non-Working Participants.

Variable	Frequency	Mean (μ)	Standard Deviation (σ)	Test Statistics	Critical Value(s)	Decision
Working	23	81.30	3.97	2.14	±2.08	Reject H_o
Non-working	23	84.27	5.34			

*P ≤ 0.05 P value = 0.038

Table 5. Descriptive Statistics and T-test of NASA-TLX Ratings: Working and Non-Working Participants.

Variable	Frequency	Mean (μ)	Standard Deviation (σ)	Test Statistics	Critical Value(s)	Decision
Working	23	65.77	12.2	-2.27	±2.08	Reject H_o
Non-working	23	58.83	8.17			

*P ≤ 0.05 P value = 0.028

Table 6. Descriptive Statistics and Unpaired T-test of NASA-TLX Rating: Full-time and Part-time Working Students.

Participant	Frequency	Mean (μ)	Standard Deviation (σ)	Test Statistics	Critical Value(s)	Decision
Full-time	5	68.87	11.82	-9.91	±2.09	Reject H_o
Part-time	18	64.91	12.49			

*P ≤ 0.05 P value = 6.0843E-09

Table 7. Descriptive Statistics of NASA-TLX Rating between Male and Female Participants.

Participant	Frequency	Mean (μ)	Standard Deviation (σ)	Test Statistics	Critical Value(s)	Decision
Male	10	62.57	12.18	-1.11	±2.08	Do Not Reject H_o
Female	13	68.23	12.10			

*P ≤ 0.05 P value = 0.2796

Findings from this research revealed that there is indeed a significant relationship between overall workload of a working engineering student to their academic performance as evident in Table 3 and Figure 2. Computed Pearson product-moment correlation coefficient r of 0.58 implies that the two variables are moderately correlated [10]. Since correlation coefficient r is greater than critical r, alternative hypothesis that there is a significant relationship between students' GWA and NASA-TLX rating is therefore accepted. This finding suggests that any moderating

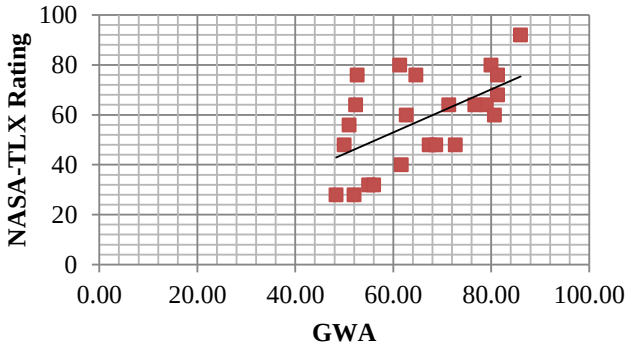

Fig. 2. Scatterplot of Correlation between NASA-TLX. Rating and GWA.

factors affecting workload can have an effect to the students' academic performance as well. Any changes and alteration in lifestyle, health, academic unit load, and current year standing can influence academic performance due to its physiological and psychosocial effects to learning. Tables 4 and 5 shows the comparative analysis of GWA and NASA-TLX rating of working and non-working students. Both yield a significant difference implying that the two groups have different workloads and academic results. In working students, they have higher workload while their academic performance is lower compared to non-working students. It is also worth noting that standard deviation of workload is high in working students due to the difference with regards to moderating factors in a group (full-time versus part-time) or in the individual level (male and female) as seen in Tables 6 and 7.

5. Conclusions and recommendations

High level of workload in an academic setting needs awareness. The administration need to consider the effects of workload to academic performance including physical and psychosocial factors in maximizing the student's potential in learning. Therefore, assessment and evaluation of the moderating factors must be considered to properly address the issue of subject retakes. With this, the number of quality graduates every year may potentially increase.

5.1. Recommendations

5.1.1. Health assessment

Brain capacity to process information and perform task correctly is largely affected by the body's physical state. Addressing physiological needs can greatly influence on how a person perceive workload. The result of this study shows 61% are overweight having a BMI of > 25.0 with an average of 25.2. This calls for a need for health assessment as BMI, especially the weight of a person is relative to health condition in general.

A thorough annual health assessment must be done to obtain the current health status of the students. For working students, it is advisable to visit the school clinic once a month for a routine check-up including blood pressure, weight monitoring and physical examination. The Engineering Department can collaborate with the school clinic in tracking the students' health condition such that the department can also advise and guide the students accordingly through faculty consultation. The school clinic will periodically update the department with the results of the check-up and immediately inform the advisers if there are indicators of fatigue or any alarming findings.

5.1.2. Daily activity

In our findings, moderating factors like lifestyle, unit load, secondary tasks (work) revealed an overview of working students' daily activity. To achieve the optimal physical well-being to better cope with high workload here are some of the recommendations that can be advised:

- As per American Heart Association (2014), doing a daily 10-20 minutes of moderate exercise helps improve overall cardiovascular health and can improve brain processing and cognition by 5 to 10 percent [11].
- In the case of our participants, a substitute to this includes walking on the way to school provided the students' lives within the 5 kilometer radius from school. Going up and down the stairs in the building can also be done. It is encouraged that the 39% of the students who lack physical activity (sedentary) to engage themselves more to an active lifestyle.
- Since 61% of the respondents revealed to be overweight, healthy restriction to unhealthy and high-calorie containing food must be observed because healthy manipulation on diet will increase resistance of neurons to damage and promote mental fitness [12]. Stress eating is becoming a trend to cope up with increasing demand in both work and academe. With this in mind, modification in the diet can yield a 20% above baseline improvement to the ability to recall information and make few errors [13]. Adequate hydration according to daily Recommended Daily Intake (RDI) for men and women can prevent problems with focusing, and trouble with math computations [14].
- Average sleeping hours of the participant is 5.7 hours a day which is below the minimum recommended hours. Enough sleep of 6 to 7 hours a day is vital to maintain cognitive skills such as learning, concentration, and memory throughout the day especially to students [15]. If sleep deprivation cannot be avoided in present unit load, consider taking few loads the next semester.
- To working students who have high unit load (35%), long hours of studying and paper writing are needed to fulfill all the course requirements. Having break times every 30 minutes while studying is also advisable because it was been proven through Organizations in Motion™ program that taking short, but frequent physical activity breaks throughout the workday made 37 percent of the participants reported high energy levels in the middle of the day (11 percent higher than pre-program) and 42 percent reported increased engagement and focus. Short meditation before going to sleep can also help cope better to high workload activities because according to [16] and [17] meditation helps improve memory, decision making, and attention span.

5.1.3. Chronotype assessment

Performance of a person in a task is largely affected by the individual's physiological state. These bodily functions and processes are regulated by an internal body mechanism called the "circadian rhythm." Optimization of these processes depends on maintaining regular adjustments of the circadian pacemaker through exposure to light through the day-night cycle. These notions revolve around the concept of chronobiology. Chronobiology is defined as the study of internal biological/circadian clocks that control physiological functions of the body while the term chronotype refers to one's internal timing [18]. Being aware of ones chronotype specially with working engineering students will maximize their academic performance because daily activities and tasks can be aligned with their individual body clock. This will help the students manage their time more effectively.

To assist the academic institution in assessing the moderating factors such as the optimal sleep hours and patterns, the proponent recommends the use of chronotype assessment to better understand individual circadian rhythm so that interventions and planning can be done to help maximize learning potential of the student. As discussed earlier, having an average sleeping hours lower than the recommendation can pose a health threat. By knowing the hours of the day a student can function with the highest productivity, it can help students plan their day and to properly allocate sleep.

The academic institution specifically the guidance and counselling office can collaborate with a research group specializing in the study of the human chronotype in the Philippines such as PhilSHIFT Research Group (PhilSHIFT). PhilSHIFT is a collaborative effort of researchers from the University of the Philippines Manila and Ludwig Maximilian Munich to study the Filipino circadian rhythm. The assessment procedure can be done through the online facility answering the Philippine Munich Chronotype Questionnaire (PhilMCTQ) section. Feedback from the assessment can be used as a basis for the students to identify the optimal schedule fit to their needs.

5.1.4. Unit load advising

For students working part-time, it is possible to take more academic load (not more than allowed units per semester) provided that physical requirement of the job is not strenuous like seated repetitive work with light parts or seated

control work. Work requiring heavy lifting or carrying work, seated with large parts and standing work may consider lowering academic unit load to prevent fatigue. For full-time workers, limit unit load to the remainder hours from the pre-determined work hours plus the advisable hours of sleep (6-7 hours a day) and allowances for preparation and travel. It is advisable to consult the advisers for further evaluation of schedules and unit loads.

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