Effects of Different Light Levels on the College Students' Cognitive Performance

Sachi Liyah S. Bautista, Shiela Mae C. Ilagan, Isabella Francesca C. Lazaro, Fea Claire B. Plantilla and Ma. Janice J. Gumasing
School of Industrial Engineering and Engineering Management
Mapua University
Intramuros, Manila, Philippines
slsbautista@mymail.mapua.edu.ph, smcilagan@mymail.mapua.edu.ph,
ifclazaro@mymail.mapua.edu.ph, fcbplantilla@mymail.mapua.edu.ph,
mjjgumasing@mapua.edu.ph

Abstract

This study aims to empirically discover the effects of different light levels on college students' cognitive performance. Due to the coronavirus pandemic, most universities, schools, and other educational institutions have halted classes and activities in response. They have been forced to shift from face-to-face to online learning and significantly impact students' daily lives, particularly those who began their first year of college entirely online. Many students spend muchof their time in their bedroom, which now has their classroom, where they join virtual classes, study, and do coursework. Our moods and cognitive capacities, such as learning and productivity, are strongly influenced by lighting.The researchers used data from a sample of 100 respondents obtained from a digital survey questionnaire containing amodified lighting ergonomics tool from the Canadian Centre for Occupational Health and Safety (CCOHS). Sixty-nine percent (69%) of participants ages 18 to 24 years old, ranging from Year 1 to 4, prefer studying at night. Regression analysis was used to determine if there are effects of light used by the students on their preferred time to study. The day and night sections were separated, but both results rejected the alternative hypothesis. The Pearson Correlation has determined the linear relationships between factors. The Analysis of Variance (ANOVA) showed no significant differences in the light levels used during daytime and nighttime. The researchers recommend exploring and considering other factors and including employees in work-from-home set-ups.

Keywords
Lighting, cognitive performance, concentration, memorization, productivity, eye strain

1. Introduction
Light has influenced human evolution. Humans have evolved an internal clock that is timed to the earth's 24-hour light-dark rotating cycle under natural sunlight conditions (Czeisler et al., 1999). Numerous variables can affect environments, and also environments have influenced people directly. People are healthier and more energized in well-designed surroundings and simultaneously. Buildings are one of these elements engaged with colors, lighting, outdoor views, and furnishing are all included in the construction and shape. Understanding the interaction between lighting and the environment might support industry professionals, or developers create good interior designs (Oneworkpalce,1999).

According to studies, daylight influences people's moods, productivity, and well-being, especially children and institutions. "Light has been the most significant environmental contribution to biological functioning."Meanwhile, artificial lighting replaces daylight, and this modern generation's culture is subjected to far morefluorescent lighting than natural light. For several years, fluorescent bulbs have been the go-to choice for schools seeking energy efficiency and improved lighting. It has developed to include full-spectrum bulbs that resemble daylight. LEDs (light-emitting diodes) have rapidly risen to prominence due to their reliability, endurance, andability to bring a continuous, smooth, and uninterrupted spectrum (Morrow, 2018). The current study looked at how

light affects neurocognitive functioning during task completion. Data shows that bright white or blue-enriched light promotes alertness and neurological processes, which has attracted researchers' curiosity. These cognitive effects, however, may not necessarily translate into behavioral advantages. Indeed, some researchers have discovered that illumination can enhance or degrade performance.

In different settings, including retail locations, workplaces, and schools, empirical research confirming the effects of lighting has already been undertaken. The outcomes of these studies reveal that the influence of illuminationdepends on the circumstances, the activity in mind, and the real context. Even though this research discovered some impacts, they do not prove or disprove the effects of illumination in various environments, asthe literature suggests. In this research, we add to the body of knowledge by investigating how workplace illuminationaffects children's concentration within an online class. While school research has revealed the importance of different elements of education systems, such as academic tasks and equipment, completion rates, responses, and educators' educational behavioral patterns, systematic empirical data with the impact of physical factors on students' learning situations, such as lighting, has already been limited. The lighting has different effects whenever the wavelength is < 300 nm (Sleegers et al., 2012). Around 300 and 400 nm, a wavelength can pass through the cornea and be absorbedby the pupil. The most dangerous wavelengths of high-energy short-wave blue light are 415 and 455 nm. Crystals that penetrate the retina directly produce permanent photochemical retinal damage. As the public becomes increasingly aware of the detrimental consequences of blue light, blue light-related eye pain is becoming a more common worry.

Light exposure at inconvenient times can disrupt human circadian cycles, which is linked to physical and mentalhealth problems. Improper light exposure and circadian lack of alignment are frequent causes of disorders, including jetlag and study hours. Furthermore, seasonal fluctuations in solar radiation have been linked to an increased risk of depression and worsening mood disorders, implying that people are prone to light exposure at all times of the day (Chul et al., 2018). According to Baniya et al. (2015), lighting preferences are connected to a range of humanresponses to light, including comfort, attractiveness, and productivity. Improved office lights with desired luminous conditions favor students, resulting in increased output, productivity, innovation, and social behavior. Two essential aspects of light to examine regarding human perception are illuminance (E) and correlated color temperature (CCT).

The study's main objective is to determine if different light levels: Low, Medium, High, and Very High affect a student's cognitive performance: Concentration, Memorization, Productivity, and Perception. The researchers also aim to determine the suitable light level for students while studying by knowing the stresses that can affect students' eyes (eye strain).

2. Review of Related Literature

Humans are primarily curious creatures (e.g., Gifford & Ng, 1982). The majority of our everyday activities depend on specific data. Because vision and, by consequence, illumination are so crucial in our daily life, they are both essentialscientific issues. Early studies indicated that a higher amount of light (illuminance) increased production significantly (Hollingworth & Poffenberger, 1926). The priority has recently changed from the illumination to the quality of light (Megaw & Bellamy, 1983). Illumination variations influence all features of human lifestyle and well-being. These have impacted our physiological and behavioral conditions, and their variations favora variety of human well-being factors. According to a study of the impact of ambient circumstances on health, there isnumerous research on the effects of light levels on human physiology. Human reactions to visual experience, vision,non-image creating effects, room, and product attractiveness, comfort, access to daylight, energy consumption, and economic advantages are explained in this section (Aries et a). A deep understanding of student demands and preferences and the elements that influence their academic performance in indoor environments isessential. Melatonin suppression, attentiveness, and cognitive functions have all been demonstrated to be affected bylighting, especially favorable spectrum tuning effects. (Barkmann et al., 2021), described the overall scientificproof about how illumination tends to affect work performance as shown in (i) vision enhanced brightness positively;
(ii) light exposure at night has an overall stimulating impact; (iii) high luminous intensity can contribute to greater concentration levels; and (iv) interactions and good behavior appear to improve at lesser brightness and especially warmer hue ambient temperature. The physical environment students study significantly affects their behaviors and attitudes. Work engagement, institutional well-being, and performance can all be influenced by a participant's pleasure with their workplace (Veitch et al., 2007). A healthy workplace depends on many

things; one of these is light. Light exposure has been proven to have a more significant impact on cognitive tasks, psychomotorvigilance, emotions, and awareness in many studies (Vandewalle et al., 2006). Room lighting is one of the environmental exposures (such as workspace and plants) that have a significant impact on students' well-being, quality of work, and sometimes even interpersonal behaviors (Baron & Thomley, 1994; Gifford, 1988). Individuals' sensationsof attention and energy, as well as task performance, have indeed been demonstrated to be influenced by illumination (Rüger, Gordijn, Beersma, de Vries, & Daan, 2003). Smolders and de Kort (2014) revealed that the psychological condition of the people influenced the favorable effect oflight levels on subjective tiredness and self-control abilities. Exposure to intense light seemed to prevent fatigue and restore self-control ability in students experiencing mental tiredness and resource exhaustion during the day. Higher luminous intensity levels during the daymay also boost mood. Bright light stimulation has been proven in studies to promote energy and relieve psychologicaldiscomfort in office workers (Partonen & Lonnqvist, 2000). It can also help people with mood disorders like seasonal affective disorder (Michalon, Eskes, & Mate-Kole, 1997). Furthermore, multiple field studies have shown acorrelation between the amount of daily light a person receives and their emotional mood and energy (Hubalek,Brink, & Schierz, 2010; Smolders, de Kort, & van den Berg, 2013). Meanwhile, several researchers have concluded that indoor lighting has little effect on mood (Baron et al., 1992; Kuller & Wetterberg, 1993). According to (Schmidt etal., 2007), during daytime school hours, a well highly controlled study was used to evaluate the influence of illuminance on young adults' cognitive function, subjective mood, and awareness. Lastly, studies have revealed that strong light exposure seems to have more favorable effects in the mornings than in the afternoon (Smolders et al., 2012).

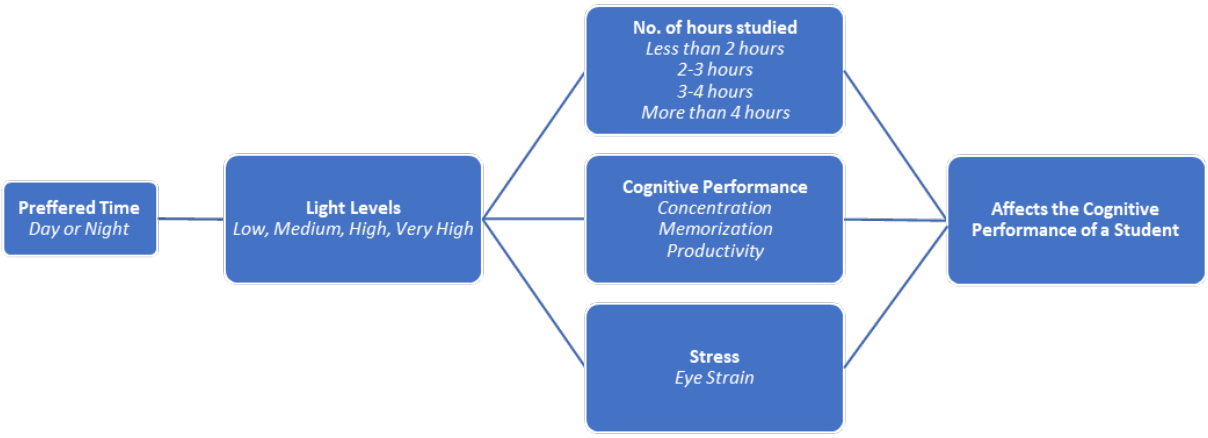

Figure 1. Conceptual Framework

3. Methods

The structure shows the scope of the analysis of the study. The study has identified two factors, cognitive performance, and stress, to know the significant effect of different light levels at different times: day and night. Itincluded the number of hours studied to determine if it adds to the identified factors. The light levels such as low,medium, high, and very high; will help identify the suitable light level that must be used during studying every dayat a different time.

The researchers formed a digital survey questionnaire comprising two sections: (1) Student Information and (2) Information on the preference of students at which time of day they like studying most. The first part of the survey gathered information on the respondents' age, year level, sex, and the time of the day they prefer studying. In the second part, students were asked how many hours they studied in a day, if they used lighting while studying, and the typeof light they preferred. The next set of questions was related to the different cognitive skills of students relating how thebrightness of light affects their concentration and memorization. The last part of the questionnaire asked if students sufferfrom eye strain after using light while doing tasks and if the brightness of the light affects their productivity. The online questionnaire was distributed to 100 respondents, targeting undergraduate students of different colleges and universities.

3.1. Ergonomic Tools

In the study, the researchers used the basic types of artificial lighting to modify the lights used by the student/respondent from the Canadian Centre for Occupational Health and Safety (CCOHS)'s Lighting Ergonomics.Wherein General Lighting is mainly used to provide uniform lighting to large areas, can be specified as the factor "Very High" (Natural Sunlight or High brightness lights' and 'High Ambient lights'; the Localized-General Lighting are similar to general lighting; however it adds other attachment/s to increase the level of light, can be modified as the "Medium" or dim lights and lastly; the Local/Task lighting is a lighting that is flexible and can be adjusted depending to the user, which can be specified as the "Low" light or desk lamps only. With these, the researchers can determine the kind of light being used during studying and see its effects on the cognitive factorsprovided in the study.

3.2 Statistical Treatment of Data

The researchers used four (4) statistical treatments of data (a) Descriptive statistics - short descriptive coefficients that sum up a data set and constitute a subset utilized to summarize the data collected from the distributeddigital survey questionnaire to reflect a population sample. (b) Pearson Correlation is performed to determine the direction of the two variables' relationship. © Multiple Regression - a statistical method for examining the relationship between multiple independent variables and a single dependent variable. The weights of each predictor value indicate their respective part of the overall prediction. Lastly, (4) Analysis of Variance (ANOVA)
- which is an analytical method for comparing variance across groups to variance within groups to investigate differences between several means and determine whether the null hypothesis should be rejected.

4. Results and Discussion

4.1. Respondents' Profile

For the profiling of respondents, most of the respondents are male, which has reached 60%, while the remaining 40% are female. As for their age, most of them are in their 20s with a percentage of 26%. Meanwhile, the respondents ages 18, 19, 21, 22, 23 and 24 have a total percentage of 74%, and have individual percentages of 6%, 17%, 21%, 15%, 11% and 4% respectively. Moreover, their year levels are obtained since the respondents are college students. Results show that most are in their second year, with 47%. Whereas 27% are in their first year, 20% are in their third year, and only 6% are in their fourth year.

4.2. Pearson Correlation Results

Concerning the correlation of no. of hours studied, usage of light, light being used, concentration, productivity, and memorization to the factors on the college students' preferred time to study, which is daytime, the analysis reveals that no. of hours studied has an intermediate positive relationship with light used and eye strain, and an intermediate negative relationship with productivity. The usage of light has an intermediate positive relationship with concentration.The light used has an intermediate negative relationship with productivity and an intermediate positive relationship with eye strain. Lastly, concentration has an intermediate positive relationship with memorization. In terms of nighttime, the results show that the no. of hours studied has an intermediate positive relationship with concentration,productivity, and memorization. The light used has a weak positive relationship with concentration and productivity. Meanwhile, concentration has a strong positive relationship with productivity and an intermediate positive relationship with memorization. Lastly, productivity has an intermediate positive relationship with memorization.

Table 1. Pearson Correlation summary (Day)

Factor	Pearson Correlation	P-value	Remarks
Eye Strain vs. no. of hours studied	0.604	<0.001	Significant
Concentration vs. Usage of light	0.537	0.002	Significant
Productivity vs. Light used	0.390	0.030	Significant
Eye Strain vs. Light used	0.418	0.019	Significant
Memorization vs. Concentration	0.422	0.018	Significant
Light used vs. no. of hours studied	0.427	0.017	Significant
Productivity vs. no. of hours studied	0.400	0.026	Significant

Table 2. Pearson Correlation summary (Night)

Factor	Pearson Correlation	P-Value	Remarks
Memorization vs. no. of hours studied	0.338	0.005	Significant
Concentration vs. light used	0.294	0.014	Significant
Productivity vs. light used	0.255	0.034	Significant
Productivity vs. Concentration	0.758	<0.001	Significant
Memorization vs. Concentration	0.642	<0.001	Significant
Memorization vs. Productivity	0.463	<0.001	Significant
Concentration vs. no. of hours studied	0.387	0.001	Significant
Productivity vs. no. of hours studied	0.305	0.011	Significant

4.2. One-Way ANOVA Results

Table 3 shows the result of the ANOVA that is used to determine the significant differences between the different light levels in the college students' preferred time of day to study, daytime and nighttime. There are 6 factors namely: the no.of hours studied, usage of light, concentration, productivity, memorization and eye strain for the different light levels. According to the results shown, there are no significant differences between the four light levels which are low (desk lamp only), medium (dim room lights), high (ambient room lights) and very high (natural sunlight or brighter lights). Hence, the null hypothesis is accepted since the result from ANOVA indicates an insignificant difference between the factors.

Table 3 . Summary of ANOVA Result

Day				
Source	**Mean**	**F-Value**	**P-Value**	**Decision**
No. of Hours Studied	2.290323	0.3	0.825	No Significance
Usage of Light	1.677419	0.39	0.683	No Significance
Concentration	2.935484	1.29	0.308	No Significance
Productivity	1.612903	0.43	0.735	No Significance
Memorization	2.129032	0.05	0.986	No Significance
Eye Strain	2.548387	0.31	0.867	No Significance
Night				
No. of Hours Studied	2.753623	1.46	0.237	No Significance
Concentration	2.434783	2.17	0.087	No Significance
Productivity	2.724638	1.3	0.281	No Significance
Memorization	2.971014	0.77	0.547	No Significance
Eye Strain	1.985507	1.39	0.252	No Significance

Ho : There are no significant differences among the different light levels.
Ha : There are significant differences among the different light levels.

4.3. Regression

The researchers utilized regression to determine if light effects are used on the preferred time to study, which is daytime, on the factors: concentration, productivity, memorization, eye strain, and the number of hours studied. The results demonstrate that all factors were found to have a p-value greater than 0.05, making them insignificant. As a result, the alternative hypothesis is rejected since regression analysis shows that the different light levels have no significant effect on the varying factors. R-squared is the percentage of the dependent variable variation that a linear model explains. Higher r-squared represents more minor differences between the observed data and the fitted values. Inthis case, the r-squared is at 35.10% or 0.3510, indicating a non-linear relationship between the dependent and the independent variables. Additionally, the regression equation and summary are shown below.

Table 4. Result of Regression Analysis (Day)

S			**R-sq**	**R-sq (adj)**	**R-aq (pred)**
0.957065			35.10%	18.87%	0.00%
Prediction	Coef	SE Coef	T-Value	P-Value	VIF
Concentration	-0.205	0.302	-0.68	0.503	1.72
Productivity	-0.125	0.2	-0.62	0.538	1.38
Memorization	-0.239	0.2	-1.19	0.244	1.29
Eye Strain	0.219	0.17	1.29	0.209	1.67
No. of hrs. studied	0.176	0.219	0.8	0.429	1.81
Usage of Light	0.021	0.238	0.09	0.929	1.53

The researchers utilized regression to determine if light effects are used on the preferred time to study, which is nighttime, on the factors: concentration, productivity, memorization, eye strain, and the number of hours studied. The results demonstrate that all factors were found to have a p-value greater than 0.05, making them insignificant. As a result, the alternative hypothesis is rejected since regression analysis shows that the different light levels have no significant effect on the varying factors. R-squared is the percentage of the dependent variable variation that a linear model explains. Higher r-squared represents smaller differences between the observed data and the fitted values. In this case, the r-squared is at 9.84% or 0.0984, indicating a non-linear relationship between the dependent and the independent variables. Additionally, the regression equation and summary are shown below.

Table 5. Result of Regression Analysis (Night)

S			**R-sq**	**R-sq (adj)**	**R-aq (pred)**
0.936003			9.84%	2.68%	0.00%
Prediction	Coef	SE Coef	T-Value	P-Value	VIF
No. of hrs studied	0.001	0.13	0.01	0.995	1.2
Concentration	0.11	0.144	0.76	0.448	3.33
Productivity	0.08	0.14	0.57	0.573	2.47
Memorization	0.066	0.136	0.49	0.628	1.77
Eye Strain	-0.083	0.118	-0.7	0.487	1.07

5. Conclusion

Light is essential for humans to live in this world. Different brightness ranges may give humans comfort ordiscomfort, resulting in various serious irreversible health conditions. With the pandemic, students andemployees had to adapt to the concept of online learning and work from home set-ups. The rise of ergonomically-designed equipment for a work area emerged through the years, but not many people have considered lighting. Thestudy's main objective is to determine whether different light levels: Low, Medium, High, and Very High can affect a student's cognitive performance: Concentration, Memorization, Productivity, and Perception. The researchers disseminated a digital survey to 100 respondents of college students and were able to gather data that was analyzedusing different statistical treatment tools. Sixty-nine percent (69%) of participants ages 18 to 24 years old, ranging fromYear 1 to 4, prefer studying at night. The Pearson Correlation has determined that the number of hours a student has allocated for studying has an intermediate positive linear relationship with the usage of light and eye strain and a negative linear relationship with productivity. The type of light used had also shown a negative linear relationship withproductivity and intermediate positive with eye strain. The Analysis of Variance (ANOVA) showed no significant differences in the different light levels used during daytime and nighttime. Lastly, Regression analysis was used to determine if there are effects of light used by the students on their preferred time to study. Day and Night sections were separated, but both results rejected the alternative hypothesis, which states that there are significant factors affecting college students' cognitive performance in relation to the different light levels.

6. Recommendation

The researchers would like to explore and consider other factors such as room color, the color of the light bulb, and the age of the light bulb to fully determine any significant effects of different light levels used by the students in their set-ups. Future researchers can also include work-from-home employees in their study to determine whether different light settings affect their productivity and cognitive skills. This paper has tackled eye strain as an effect of varying light levels. Future researchers can also consider other health effects if they wish to delve deeper into the different effects of light levels. The rise of LED light strips has also taken off this pandemic. Future researchers can focus on or include this in their studies since not all light settings are healthy for the eyes. It does its purpose for aesthetics, but researchers can investigate if this improves the productivity of people using the said light.

In practice, students should avoid placing their monitors directly in front of windows or white walls to prevent eye strain. It is vital to keep the monitors at arm's length to avoid putting stress on the eyes from too much blue light emitted by digital monitors. Blue light glasses can also help protect the eyes from very harmful blue light emitted by screens. These kinds of glasses are available in the market today. One should also learn which color of light they find best and find the most comfortable.

References

Boray, PF., Gifford, R., Rosenblood., L. (1989). *Effects of Warm White, Cool White and Fullspectrum Fluorescent Lighting on Simple Cognitive Performance, Mood and Ratings of Others*. *Journal of Environmental Psychology (1989) 9, 297 308*. doi: 10.1016/S0272-4944(89)80011-8

Choi, K., & Suk, H.-J. (2016). *Dynamic lighting system for the learning environment: performance of elementary* Choi, K., & Suk, H.-J. (2016). Dynamic lighting system for the learning environment: performance of elementary students. Optics Express, 24(10), A907. doi:10.1364/oe.24.00a907 students. Optics Express, 24(10), A907. doi:10.1364/oe.24.00a907

Czeisler, C. A., Duffy, J. F., Shanahan, T. L., Brown, E. N Mitchell, J. F., Rimmer, D. W., & . . . Kronauer, R. E. (1999). Stability, precision, and near 24-hour period of the human circadian pacemaker. Science, 284, 2177-2181.

Government of Canada, C. C. for O. H. and S. (2022, April 27). *Lighting Ergonomics - General : Osh answers*. Canadian Centre for Occupational Health and Safety. Retrieved May 4, 2022, from https://www.ccohs.ca/oshanswers/ergonomics/lighting_general.html

J.A. Veitch, Farley & Newsham. (2014). Occupant preferences and satisfaction with the luminous environment and control systems in daylight offices: a literature review, Energy Build. 38(7)(2006) 728-742. Doi: 10.1016/S0272-4944(89)80011-8

K.C.H.J. Smolders, Y.A.W. de Kort. Bright light and mental fatigue: effects on alertness, vitality, performance and physiological arousal, J. Environ. Psychol. 39(2014) 77-91. doi: 10.1016/j.jenvp.2013.12.010

Keis, O., Helbig, H., Streb, J., & Hille, K. (2014). Influence of blue-enriched classroom lighting on students′ cognitive performance. Trends in Neuroscience and Education, 3(3-4), 86–92. doi:10.1016/j.tine.2014.09.001

Mills PR, Tomkins SC, Schlangen LJM. The effect of high correlated colour temperature office lighting on employee well-being well-being and work performance. J Circadian Rhythms 2007;5(1):2. Doi: 10.1186/1740-3391-5-2

Morrow, L & Kanakri, S. (2018). The impact of fluorescent and LED lighting on students attitudes and behavior in the classroom. *Advances in Pediatric Research*. https://doi.org/10.24105/apr.2018.5.15

Mott, M. S., Robinson, D. H., Walden, A., Burnette, J., & Rutherford, A. S. (2012). Illuminating the effects of dynamic lighting on student learning. *SAGE Open*, *2*(2), 215824401244558. https://doi.org/10.1177/2158244012445585

Oneworkpalce. (1999). Seeing the Difference, The importance of Quality Lighting in the Workplace. Workplace Issues. Retrieved from http://www.pdf-finder.com/The-Importance-of-Quality-Lighting-in-the- Workplace.html

Phipps-Nelson, J., Redman, J., Dijk, D., & Rajaratnam, S. (2003). Daytime Exposure to Bright Light, as Compared to Dim Light, Decreases Sleepiness and Improves Psychomotor Vigilance Performance. Sleep, Volume 26, Issue 6(2003), p 695–700. doi: 10.1093/sleep/26.6.695

Yildirim, K., Baskaya, A.A., & Hidayetoglu, M.L. (2006). Effects of indoor color on mood and cognitive performance. Building and Environment 42 (2007) 3233–3240. doi: 10.1016/j.buildenv.2006.07.037

Biographies

Sachi Liyah S. Bautista is a 2nd-year undergraduate college student in Mapua University - Intramuros, taking a degree in Bachelor of Science in Industrial Engineering. She is a current member and the Assistant Newsletter Head of the Production and Operations Management Association of the Philippines (PROMAP) - Mapua Intramuros Chapter. Her previous studies tackle disciplines with respect to students and education and social media.

Shiela Mae C. Ilagan is a 2nd-year undergraduate college student in Mapua University - Intramuros, taking a degree in Bachelor of Science in Industrial Engineering. She is a current member of the Production and Operations Management Association of the Philippines (PROMAP) - Mapua Intramuros Chapter. Her previous studies tackle disciplines with regards to students—grit and their performance, education and social media messaging platforms.

Isabella Francesca C. Lazaro is a 2nd-year undergraduate college student in Mapua University - Intramuros, taking a degree in Bachelor of Science in Industrial Engineering. Her previous studies include student, social media messaging platforms, facilityplanning, and gender discrimination on products.

Fea Claire B. Plantilla is a 2nd-year undergraduate college student in Mapua University - Intramuros, taking a degree in Bachelor of Science in Industrial Engineering. She is a current member of Philippine Institute of Industrial Engineering and Financial Manager of the production and Operations Management Association of the Philippines (PROMAP) - Mapua Intramuros Chapter. Her previous studies tackle disciplines with regards to student and education and social media.

Ma. Janice J. Gumasing is an Associate Professor in the School of Industrial Engineering and Engineering Management at Mapua University. She has earned her B.S. degree in Industrial Engineering, Master of Engineering degree, and Ph.D. in Industrial Engineering from Mapua University. She is a Professional Industrial Engineer (PIE) with over 15 years of experience. She is also a professional consultant for Kaizen Management Systems, Inc. She has taught courses in Ergonomics and Human Factors, Cognitive Engineering, Methods Engineering, Occupational Safety and Health, and Lean Manufacturing. She has numerous international research publications in human factors and ergonomics. She has been awarded a Woman in Academia (WIA) 2019 during the International Conference of Industrial Engineering and Operations Management held in Bangkok, Thailand; the Young Researcher Award at the 2020 International Conference of Industrial Engineering and Operations Management in Dubai, UAE; and the Outstanding Conference Contributor Award at the 2021 International Conference of Industrial Engineering and Operations Management in Singapore