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RESEARCH ARTICLE

Environmental Ergonomics Affecting Students Comfort In A Vocational College

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Abstract

Environmental ergonomics is defined a scientific study of the effects of ambient environmental conditions on human comfort, performance and health. Knowledge on ergonomics, importance of safety, and environmental ergonomic conditions are the essential factors to ensure students' comfort during practical work in the workshop. This study aims to assess environmental ergonomic conditions regarding lighting, noise and temperature that affect students' comfort during practical session in a vocational college. This study compared two groups namely Welding Technology and Electronic Technology. Welding Technology students are exposed to high noise, high temperature, and need adequate lighting while Electronic Technology students are not exposed to the high noise and high temperature during the practical session. There is a significant difference of environmental ergonomic conditions between Welding and Electronic Technology students ($0.01 = p < 0.05$). There is no significant difference in comfort level between Welding and Electronic Technology students ($0.39 = p > 0.05$). There is association between environmental ergonomics and students' comfort level ($0.04, 0.02, 0.01 = p < 0.05$). The interaction between students and their surrounding environment is one of the key important aspect in workshops. A number of 79.6% students agreed that the noise of the machine interrupts them emotionally during practical work. Majority of the environmental ergonomics measurement level in the workshop did not comply with the established standards. The environmental ergonomics is helpful to contribute ideas for improvements in the design of the workplace to enhance students' comfort.

Keywords: *Environmental ergonomics, students' comfort, vocational college, workshop*

INTRODUCTION

Environmental ergonomics is a scientific study of the effects of ambient environmental conditions on human comfort, performance and health (Hedge et al., 2000). Knowledge on ergonomics, importance of safety, and environmental ergonomic conditions are the essential factors that ensure comfort during practical work in the workshop (Mohd Rizal et al., 2010). Environmental ergonomics is concerned with how the people interact with the environment from the perspective of ergonomics. Environmental ergonomics is an important and valuable tool in workshop building design (Dianat et al., 2016).

In a work environment, the continuous and dynamic interaction between people and their surroundings can causes physiological and psychological strain which consequently affects their comfort, performance, productivity, safety and health (Parsons et al., 2000). To ensure reliability in the assessment of the environmental ergonomic conditions in each working environment, it has been suggested that both objective measurements such as physical measurements of lighting, noise, and temperature along with subjective assessments should both be taken into account. Subjective assessments should include comfort, satisfaction, perceived job performance, and health and safety consequence (Dianat et al., 2013).

Ergonomics is the aspect that should be emphasised when practicing in a workshop to prevent accidents and to create a positive working environment in the aforementioned workshop thus reducing stress and inducing satisfaction and well-being among the students in the workshop. Reduction in stress and emotional disturbances can lead to increment of emotional and motivational support. Poorly designed working environments or inadequate management of environmental factors could significantly affect one's

health, well-being, and overall performance (Skilling et al., 2017).

METHODOLOGY

Study design and setting

The study was conducted at a vocational college in central Johor. This study adopted the cross-sectional design to identify the correlation between environmental ergonomic conditions and students' comfort during practical session. This study presented on the effects of environmental ergonomic conditions on the comfort of students, and ergonomics assessments were made. This study compared two groups namely exposed group and control group. Exposed group is students of Welding Technology while control group is students of Electronic Technology. Welding Technology students are exposed to high noise, high temperature, and need adequate lighting while Electronic Technology students are not exposed to the high noise and high temperature during the practical session. This study used instruments such as Light Meter, Sound Level Meter, and Heat Stress Monitor to get readings in the workshop. The questionnaire was used to measure the comfort level among students and to obtain their information.

Study samples

The study samples consist of students from vocational college. A number of 226 students of Welding Technology course and Electronic Technology course were chosen as the study sample because the Welding Technology students are exposed to high noise, high temperature, and need adequate lighting during the practical session. Electronic Technology students were chosen as control group because the students are not exposed to the high noise and high temperature. Students with myopia and hearing problems were considered as exclusion criteria for the study.

Data collection

Physical measurements of the environmental ergonomic conditions regarding lighting, noise, and temperature, the tools were used were sound level meter (model Cirrus CR:812C), light meter (model Extech HD450), and heat stress monitor (model 3M™ QUESTemp™ 36). To measure the comfort level of students during practical session in the workshop, a questionnaire was distributed to the students to be answered to measure the comfort level among students of Welding Technology and Electronic Technology courses during practical session. There are 30 questions in this questionnaire, each item uses a 3-point Likert scale; (1) Disagree, (2) Not sure, and (3) Agree. The questionnaire is divided into two parts, Part A is the demographic information of the respondents, and Part B encompasses questions that covers the aspects of knowledge on ergonomic, the importance of safety and environmental ergonomic conditions.

Data analysis

The analysis of the data, including descriptive statistics, was performed using IBM SPSS Statistical Version 23. This software was used to obtain the frequency, percentage, and mean of the statistical data of environmental ergonomic conditions and students' comfort. Besides that, this software was used to determine the normality of the data for hypothesis testing. The alpha value set in this study is 0.05. To test the hypothesis, this test is based on the significant value of t-test for Equality of Means. The hypothesis testing was conducted to determine whether an environmental ergonomic conditions was affecting the comfort level of students during practical session in the workshop. Testing of this hypothesis is based on the significant value of Pearson Chi-square test. A significance level of $p < 0.05$ was considered for all statistical tests.

RESULTS AND DISCUSSION

Ergonomics assessment

The results showed that ergonomic environments such as lighting, noise, and temperature influence students during the workshop at a high level with a mean value of 2.61 (Table 1). Students also agreed that the noise of the machine interrupts their emotionally when doing practical work. This can be proven by the highest mean value recorded on the item 10 at 2.75. Overall, items 3, 8, and 10 indicate most highest mean values of 2.71, 2.71, and 2.75.

Table 1 The data analysis for environmental ergonomic conditons.

Questions	Agree		Not Sure		Disagree		Mean
	f	%	f	%	f	%	
Machines such as welding machines, metal cutting machines and grinding machines are placed in a well-lit area.	144	63.7	52	23.0	30	13.3	2.46
The height of the light source is suitable for lighting in the workshop.	162	71.7	34	15.0	30	13.3	2.58
I am comfortable with the space in the workshop when doing practical work.	168	74.3	33	14.6	25	11.1	2.71
There is air circulation to prevent hot air in the workshop.	146	64.6	49	21.7	31	13.7	2.52
All openings such as windows, transparent roofs and doors in the workshop work well.	144	63.7	53	23.5	29	12.8	2.51
I feel comfortable with the environmental condition when doing practical work in the workshop.	146	64.6	57	25.2	23	10.2	2.53
A clean and orderly working environment is a factor that provides comfort when doing practical work.	165	73.0	39	17.3	22	9.7	2.64
The workshop wall area does not place objects that can cause injury.	165	73.3	38	16.6	23	10.1	2.71
It is too noisy in the workshop and that disturbs my concentration during practical work.	158	69.9	43	19.1	25	10.9	2.65

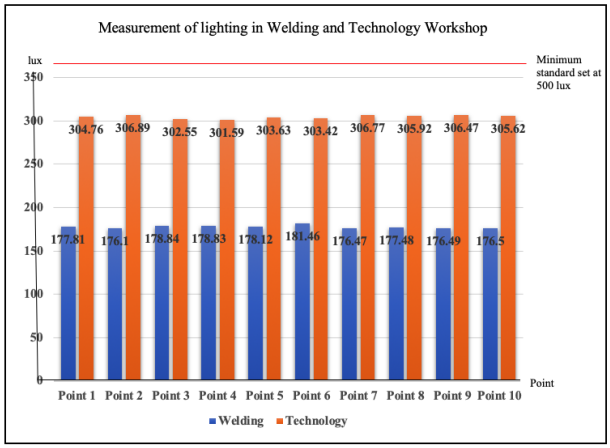
The noise of the machine interrupts me emotionally to pressure me.	180	79.6	31	11.5	15	8.8	2.75
							2.61

Environmental ergonomic conditions

There is a significant difference of environmental ergonomic conditions between Welding and Electronic Technology students ($0.01 = p < 0.05$). This hypothesis is approved and supported by the independent sample t-tests that were performed.

i. Lighting

Measurement of lighting was taken at ten different areas in the Welding and Technology workshops. The mean value of the lighting level for the Welding Technology group is 177.81 lux while for the Electronic Technology group is 304.76 lux. There are two sources of lighting in Welding and Electronic Technology workshop which are natural and mechanical lighting. Guidelines on Occupational Safety and Health for Lighting at Workplace 2018 set the minimum standard for educational buildings (teaching workshop) is 500 lux. Fig. 1 shows that all measurements of lighting level for both Welding and Electronic Technology workshop is not compliant with the standard. Based on the observations at the workshop, this problem is due to dysfunctional and damaged fluorescent lights. This problem limits the lighting source in the workshop and the students were exposed to visual discomfort and physical accidents. Inadequate lighting condition can cause discomfort to the occupants of a workplace and also affect both human performances at general tasks and visual performance (Dianat et al, 2013).

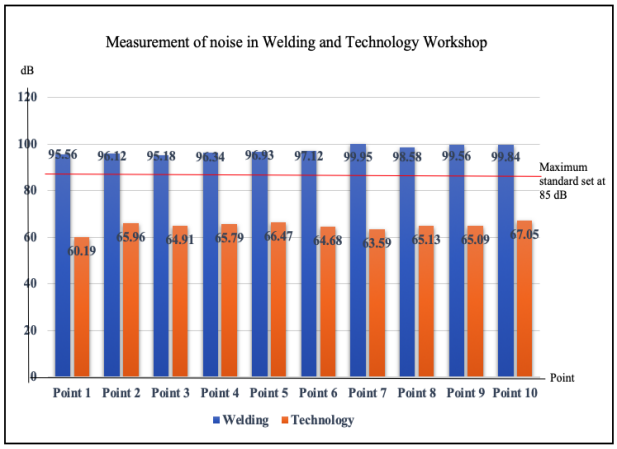


*According to Guidelines on Occupational Safety and Health for Lighting at Workplace 2018

Fig 1 Measurement of lighting in Welding and Technology workshops.

ii. Noise

The measurement of noise was taken at ten different areas in the Welding and Technology workshops. The mean value of the noise level for the Welding Technology group is 97.52 dB while for the Electronic Technology group is 64.89 dB. Occupational Safety And Health (Noise Exposure) Regulations 2019 set the maximum standard is 85 dB.Fig 2 shows that all measurements of noise level in Welding Technology workshop do not comply with the standard while the measurement of noise point level in Electronic Technology workshop complies with the standard. The cause of high noise level in the workshop is generated from the machines such as grinding machines and metal cutting machines. Short-term exposure to high noise levels can lead to temporary hearing loss or reduced ability to hear within a person's normal range, tinnitus which is described as a ringing in the ears and can affect sleep, inability to communicate, distraction, and reduced concentration (Skilling et al, 2017). Numerous researchers agree that noise is a major factor of discomfort and disturbance for employees (Perrin et al., 2017).

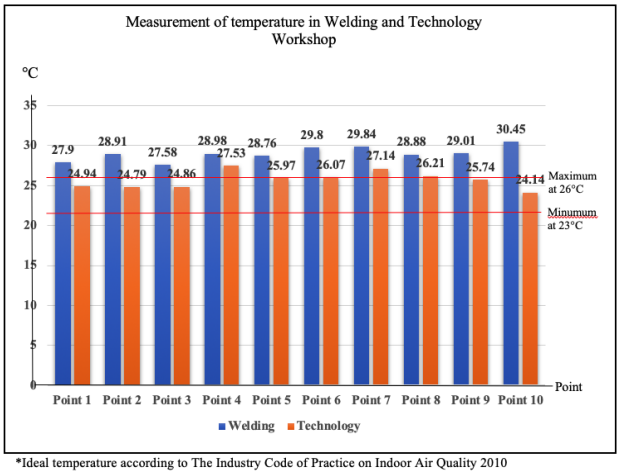


*According to Occupational Safety And Health (Noise Exposure) Regulations 2019

Fig 2 Measurement of noise in Welding and Technology workshops.

iii. Temperature

The measurement of temperature was taken at ten different areas in the Welding and Technology workshops. The mean value of the temperature level for the Welding Technology group is 29.01°C while for the Electronic Technology group is 25.78°C. The Industry Code of Practice on Indoor Air Quality 2010 stated that the ideal temperature for the working environment is between 23°C to 26°C. Fig 3 shows that all the measurements of temperature level in Welding Technology workshop do not comply with the standard while there are four points of measurement of temperature level in the Electronic Technology workshop that do not comply with the standard. The primary reason for the high temperature level in the workshop is poor ventilation system that is caused by dysfunctional exhaust fan. Apart from that, the heat produced by the grinding machines and metal cutting machines also lead to high level of temperature in the workshop. This problem may lead to heat stress and heatstroke which will lead to one having the inability to process information or communicate coherently. Thermal discomfort caused by the internal or external environment being too hot or too cold might lead to a variety of psychological or physical effects (Skilling et al, 2017).



*Ideal temperature according to The Industry Code of Practice on Indoor Air Quality 2010

Fig 3 Measurement of temperature in Welding and Technology workshops.

Students' level of comfort

There is no significant difference in comfort level between Welding and Electronic Technology students. (0.39 = p > 0.05). This hypothesis is approved and supported by the independent sample t-tests that were performed. Environmental ergonomic conditions is important as it influences the students' during their practical work in the workshop. This can be proven by the mean of environmental ergonomic conditions has the highest mean value which is 2.61. A total 79.6% students agreed that the noise of the machine interrupts their emotionally when doing practical work. Excessive noise level at school areas can affect psychology and physiology of both teachers and students (Ismail et al., 2015). A total 63.7% students also agreed the machines such as welding machines, metal cutting machines and grinding machines are placed in a well-lit area. This should be emphasized because poor lighting and poor visibility can contribute to accidents and poor performance as well as "momentary blindness" (Skilling et al., 2017).

Environmental ergonomics affecting students' comfort level

There is association between environmental ergonomics and students' comfort level (0.04, 0.02, 0.01 = p < 0.05). This hypothesis is approved and supported by the Pearson Chi-square test. Based on the data analysed from the questionnaire, environmental ergonomic conditions has the high mean value (2.61). 79.6% students also agreed that the noise of the machine interrupts their emotionally when doing practical work. A physiological and psychological strain on the person affected by the dynamic and longing interaction occur between human beings and their perspective surroundings (Parsons et al., 2000).

In addition, majority of the environmental ergonomic conditions measurement level in the workshop did not comply with the recommended standards. This problem occurred due to dysfunctional and damaged fluorescent lights, noise generated from the machines, and poor ventilation system that is caused by dysfunctional exhaust fan. This will affect students' physical and psychological aspects and quality of work. There are instances in which students' comfort is tampered due to the environmental disturbances in the workshop. Poorly designed work environment and poorly managed environmental factors, such as noise, extreme temperature, and inadequate lighting, can significantly affect one's overall work environment, health, well-being, and performance (Skilling et al., 2017).

There are several signs which reflect poor housekeeping and cleanliness at the vocational college workshop. Some of these signs are cluttered and poorly arranged work areas, untidy and dangerous storage of materials such as materials stuffed in corners and overcrowded shelves, dusty and dirty floors, tools and equipment left in work areas instead of being returned to proper storage places and broken containers and damaged materials. In order to improve students' comfort in the workshop, the school management should establish a housekeeping programme: a programme that focuses on an organised storage and movement of materials. The housekeeping responsibilities can be integrated in their work by having these students to clean up after their waste and unused materials, in addition to inspecting their work area to ensure the cleaning process is properly done and completed. Knowing the ways to keep their workspace safe and comfortable is pertinent to ensure comfort while doing practical work in the workshop. A previous study concluded that vocational education students have limited knowledge on how to prevent health risks at work and lack a systematic way to approach hazard control (Öner et al., 2017).

CONCLUSION

The findings of this study have provided additional evidence and a useful support on the effects of environmental ergonomics on students' comfort, particularly in vocational college workshops. The recommended lighting, noise, and temperature levels were not met in about half of the workshops surveyed. Poorly designed work environment and poorly managed environmental factors, such as noise, extreme temperature, and inadequate lighting, can significantly affect one's overall work environment, health, well-being, and performance. The results of this study have helped to contributes ideas for improvements on environmental ergonomic conditions and the design of the workplace to enhance students' comfor as Environmental ergonomics can be a valuable tool in workshop building design. The details of control measures are presented in Table 2.

Table 2: Control measures for environmental ergonomic parameters in the workshop**.**

Parameter	Control measure
Lighting	Increase the lighting to a comfortable level by providing lighting with adjustable intensity to increase the viewing time and the brightness of the work piece. Use light colours and matte finishes on walls, ceilings and floors to reflect light and enhance the output of the lighting system. Paint stationary and moving parts of machinery with contrasting colours, such as black and orange. With print materials, use black type against a white or light-coloured background.

Temperature	Increase air movement by mounting large diameters ceiling fan, exhaust fan, and air-conditioning. Control the amount of work and rate of work students are expected to do.
Noise	Choosing low-noise tools and machinery, maintaining and lubricating machinery and equipment, placing a barrier between the noise source and employee, and enclosing or isolating the noise source. Conduct a noise conservation training programme by limiting the amount of time the students spends at a noise source and providing quiet areas where students can gain relief from hazardous noise sources.

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REFERENCES

Akta Keselamatan dan Kesihatan Pekerjaan 1994 (Akta 514). “Peraturan-Peraturan Dan Perintah-Perintah”. Kuala Lumpur: International Law Book Services.

Dianat, I., Sedghi, A., Bagherzade, J., Jafarabadi, M. A., & Stedmon, A. W. (2013). *Objective and subjective assessments of lighting in a hospital setting: implications for health, safety and performance. Ergonomics, 56(10), 1535-1545*.

Dianat, I., Vahedi, A., & Dehnavi, S. (2016). Association between objective and subjective assessments of environmental ergonomic factors in manufacturing plants. *International Journal of Industrial Ergonomics, 54, 26-31.*

Marzuki, I., Samsuri., A. & Yuen, F. S. (2015). Study on environmental noise pollution at three different primary schools in Kuala Terengganu, Terengganu State*. Journal Sustainable Science Management, 10, 103-111.*

Öner, S., Tanır, F., Aktaş, H., Okyay, R. A., & Şaşmaz, T. (2017). Use of personal protective equipment and factors associated with injuries among vocational and technical high school students. *Evaluation, 36,41.*

Parsons, K. C. (2000). Environmental ergonomics: a review of principles, methods, and models. *Applied Ergonomics, 31(6), 581-594.*

Perrin Jegen, N., and Chevret, P. (2017). Effect of noise on comfort in open-plan offices: application of an assessment questionnaire*. Ergonomics 60; 6-17.*

Said, M., Rizal, M., & Zahari, R. (2010). Kajian Aplikasi Ergonomik Terhadap Pelajar Ketika Melakukan Kerja-Kerja Amali Bengkel Di Kalangan Pelajar-Pelajar 4 SPH PKPG. *Kajian Aplikasi Ergonomik Terhadap Pelajar Ketika Melakukan Kerja-Kerja Amali Bengkel Di Kalangan Pelajar-Pelajar 4 SPH PKPG, 1-8.*

Mustafa, S.A. 2007. *Aplikasi Ergonomik Dalam Sistem Kerja Untuk Kesejahteraan Motivasi Pekerja Menggunakan Terminal Paparan Visual*. Tesis Ijazah Sarjana Sains, Universiti Sains Malaysia.

Skilling, E. J., & Munro, C. (2017). Environmental ergonomics. In *Human Factors in the Chemical and Process Industries* (271-290). Elsevier.