Ergonomic Redesign of Computer Laboratory to Improve Electric Power Performance and Working Efficiency

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Abstract

The current problems in the Computer Laboratory of Udayana University Technical Engineering Faculty include non-standard room temperature of 28 ^{O} C, non-standard light intensity average in the room of 110 lux, seat height of 43 cm and table height of 74,50 cm being not adapted to the workers' anthropometric measurements, and dazzling white-colored curtains. Baseline data on six students after 3-hour working revealed the following findings: eye fatigue 81%' and general fatigue 88%; musculoskeletal complaints 51%; average learning achievement 59.5%, performance 16.25%, and efficiency 10.09%. In an effort to improve the working conditions, a total experimental ergonomic intervention in the form of redesigning the Computer Laboratory was introduced.

In this study 30 subjects were recruited. The data collected were analyzed by using desriptive statistics, normality test, comparability test, and paired-simple t-test with a significant level of 5%.

Total ergonomic intervention has resulted in a decrease of room temperature from 28^{0} C to 25.83^{0} C ($p<0.05$), increase in light intensity from 110 lux to 136.67 lux, decrease in eye fatigue from 81% to 23% ($p<0.05$), decrease in general fatique 88% to 41%, decrease in musculoskeletal complaints from 51% to 11% ($p<0.05$), increase in learning achievement score from 59.5% to 89.5% ($p<0.05$), increase in performance from 16.25% to 41.25%, and increase in efficiency from 10.09% to 75.09% ($p<.05$).

The results of this study revealed that appropriate total ergonomic intervention in a computer laboratory had succeeded in improving the quality of working and performance of the workers.

Key words: Ergonomic redesign, efficiency in electric power performance and use, learning and working efficiency

INTRODUCTION

Education is a conscious and deliberate effort to create an atmosphere of learning and the learning process so that learners are actively developing the potential for him to have the spiritual strength of religious, self-control, personality, intelligence, noble character, and the skills needed in society. One of the main basic education is to develop a culture between generations. This educational path has a clear educational levels, ranging from basic education, secondary education, to higher education.

In the current educational development, knowledge can be easily acquired, through effective learning by book reading, TV media, and other electronical media, such as computer and internet. In the education, the existance of a laboratory is very importance in the prosess of teaching and leaning prosess for the best student's performance. Laboratory as a student learning center shall always be active in process of research and is pursuant to development of knowledge and technology in its field (UNISBA, 2009

Practicum is done based on the curriculum prescribed by the majoring. The width and ceiling height of the majoring in electrical engineering computer laboratory respectively is 55,05 m and 3,44 m. The limited space resulted a problem such as difficulty in doing practicum task since number of facilities and users is not balanced. The capacity of laboratory room only for 17 computer units.

From the empirical study, there were some data found, namely (a) the room temperature 28 C; (b) the in-the-room light intencity average 110 lux; (c) the chair holder height 43 cm, table height 74,50 cm; (d) white curtain.

The total ergonomic approach was done with ergonomi intervention, that was a repair of lighting, temperature, chair and table height, curtain, distance between-eye-and computer, distance between table. The repair to the lighting and temperature was done by recalculating based on space volume.

MATERIALS AND METHOD

The population this research was the semester III student of Electrical Engineering Department Udayana University. The number of sample in this research are 26 people calculated with Colton formula (1985). The sample number was added 15% to avoid research subject is drop out, the sample size was set 30 people. The research subject was chosen based on criteria with simple randon sampling, using random numbering table (Hadi, 1995).

This study is a real experimental studies with the same subject design (treatment by subject) (Isaac and Michael, 1971; Hidi, 1995; Bakta, 1997).

The data obtained was processed with program of SPSS 13.00. Due to normally distributed data, the hypothesis testing were tested using the parametric statistic , that is paired-sample t-tes.

RESULT

Tabel 1 Physical Characteristic Subject

Subject Characteristic

Variabel	Average	SB	Range
Age (year)	18.97	0.81	18-20
Body Weight (kg)	63.37	6.14	45-96
Body Height (cm)	16787	6.55	156.5-182

Table 2. Difference Test of Environmental Condition at Computer Laboratory Electrical Engineering Department

Environment Condition

Variable	Before Redesigning		After Redesigning		Average Difference	t	P
	Average	SD	Average	SD			
Dry Temperature (^{0}C)	28.00	0.50	25.83	0.76	2.17	4.91	0.04*
Wet Temperature (^{0}C)	23.67	1.04	20.83	0.58	2.84	4.71	0.04*
Humidity (%)	72.67	4.04	62.17	0.58	10.50	5.25	0.03*
Noise (dB) (A)	33.87	8.07	33.77	7.63	0.10	0.30	0.78
Light Intencity (lux) TL 2x36 watt	110.00	11.83	246.67	8.16	-136.67	-23.29	0.001*

Table 3. Average Difference Between Performance and Efficiency of Useing Electric Power

a. Eye Fatigue

Variable	Before Redesigning		After Redesigning		Average Difference	t	p
	Average	SD	Average	SD			
Eye Fatigue Before Practicum	9.10	1.06	9.03	1.10	0.07	0.49	0.63
.Eye Fatigue After Practicum	30.67	3.44	12.87	1.80	17.80	26.36	0001*
Difference	21.57	3.46	3.83	1.56	17.73	27.35	0.001*

b. General Fatigue

Variable	Before Redesigning		After Redesigning		Average Difference	t	P
	Average	SD	Average	SD			
General Fatigue Before Practicum	31.17	0.99	31.07	0.91	0.10	1.80	0.08
General Fatigue After Practicum	69.93	1.78	37.10	3.77	32.83	44.76	0.001*
Difference	-38.77	2.11	-6.03	-3.62	-32.73	44.73	0.001*

c. Musculoskeletal Fatigue

Variable	Before Redesigning		After Redesigning		Average Difference	t	P
	Average	SD	Average	SD			
Musculoskeletal Fatigue Before Practicum	29.80	1.77	29.70	1.73	0.10	1.80	0.08
Musculoskeletal Fatigue After Practicum	56.30	3.32	33.50	2.71	22.80	28.40	0.001*
Difference	-26.50	3.67	-3.80	2.33	-22.70	28.40	0.001*

d. Study Achievement

Variable	Before Redesigning		After Redesigning		Average Difference	t	p
	Average	SD	Average	SD			
Test Completing Duration (minute)	109.67	5.40	85.33	5.24	-24.33	20.41	0.001*
Test Score	59.60	4.05	82.53	3.87	22.93	-19.34	0.001*

e. Comparison Between Performance and Electric Power Use

	Before Redesigning		After Redesigning		Average Difference	t	p
	Average	SD	Rerata	SD			
Comparison Between Perfomance and The use of Electric Power	39,30	17,86	21,26	13,70	18,04	4,71	0,00*

RESULT ANALYIS

Subject characteristic analyzed was age, body wight, and body height. The subject age average was 18.97 year with range 18 to 20 years. The similar age range was reported by Lilik (2010) namely 18 to 20 year. The average of subject body weight was 63.37 kg with range 45 to 96 kg. The average of the subject body height was 167.87 cm with range 156.5 to 182 cm.

Environmental Condition

Temperature Condition and Humidity

Before redesigning was obtained average of dry temperature 28 C, wet temperature 23.67 C, and humidity 62.17%. obtained After redesigning dry temperature, wet temperature, and relative humidity respectively were 25.83 C, 20.87 C, and 62.17%.

Condition was obtained by recalculation based on space volume, that temperature standard condition for Indonesian people was gained. Ibach (2008) stated that the convenient room temperature of work environmental is 26 C. On research Parwata (2008) obtained wet temperature before redesigning was 23.66 C and after redesigning was 23.09 C.

Increase in the Light Intensity

Light intensity average condition before redesigned obtained with measurement was 110 lux, obtained from 2 lamps TL 2X36 watt. After redesigned wiht recalculation to volume light intensity needed for study room was 250-500 lux (Harten and Setiawan, 1985). The recalculation result showed the lamp light intensity average of with eight TL watt 2X36, is 246.67 lux. Darmasetiawan and Puspakesuma (1991), in their research that recommended strength light average intensity in class was 250 lux.

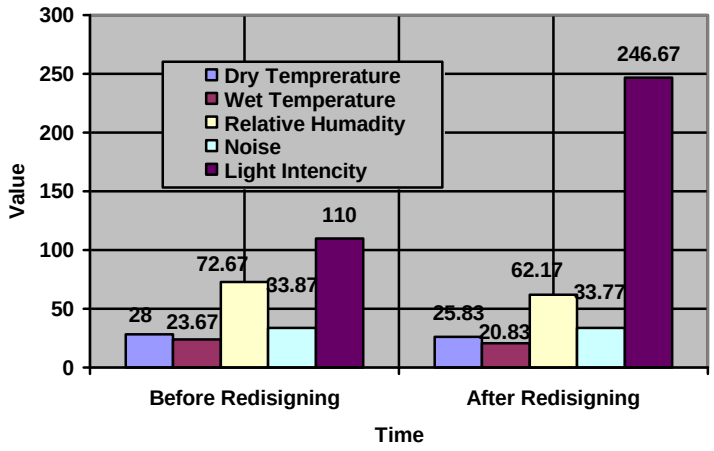

Figure 1. Environmental Condition Before and after Redesigning

Eye Fatigue

Result of analysis on eye fatigue before practicum, before and after redesigned did not show any difference with value p>0,05. The average of eye fatigue upon the practicum before redesigned was 30.67±3.44 and after redesigning was 12.87±1.80. The analysis result showed a meaningful decrease in eye fatigue 58%. Thus, the 1st hypothesis was

proved with the appearance of a decrease in eye disease. The result is supported by Aryanti (2006) stating that there is a significant correlation between lighting and temperature with eye fatigue.

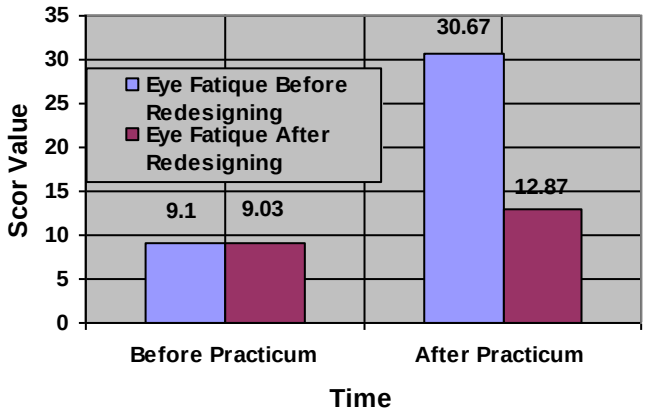

Figure 2. Decrease in Student's Eye Fatigue after Redesingin Penurunan Kelelahan Mata Mahasiswa Setelah Computer Laboratory Redesigning

General Fatigue

The before- and after practicum general fatigue did not significantly with p>0,05. The average of general fatigue before redesigned was 69.93±1.78 and after redesigned 37.10±3.77. The decrease occurred on eye fatigue as a result of temperature repair of 47%. Therefore, the 2nd hypothesis was proved by decrease in general fatigue.

Wijana (2008) in his research done at SD 1Sangsit, Distric of Sawan, Buleleng Regency resulted in a decrease in general fatigue 73.77%. The difference was caused by difference of object used.

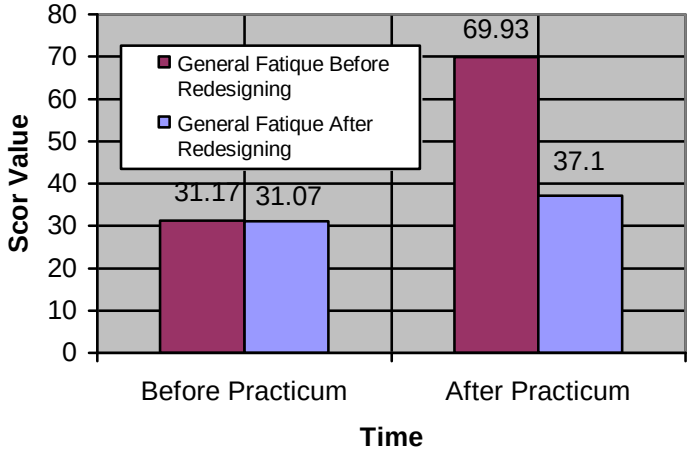

Figure 3. Decrease in Students' General Fatigue Before Computer Laboratory Redesigning

Musculoskeletal Complaint

Musculoskeletal complaint before and after redesigned was not different with value of p>0,05. Musculoskeletal complaint average before and after redesigned were

respectively 56.30±3.32 and 33.50±2.71. There was decrease in Musculoskeletal complaint after some repair to the work chair 40%. The third hypothesis proved with obtained a decrease on musculoskeletal complaints.

Admin (2010) stated that working chair repair in accordance with the workers's anthropometry can reduce musculoskeletal complaint.

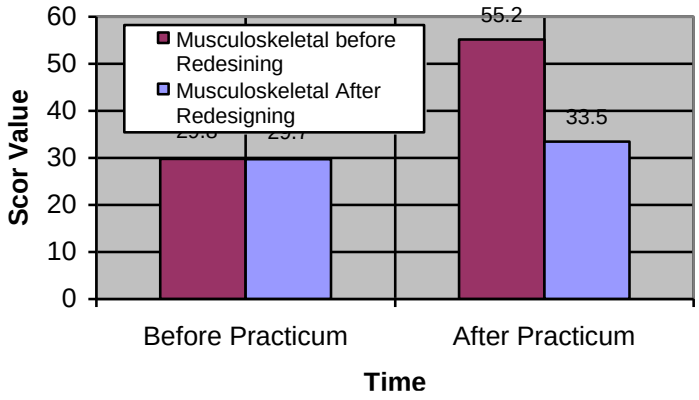

Figure 4. Musculoskeletal Complaint of Student Before and After Practicum at Before and After Redesign of the Computer Laboratory

Study Achievement

The result achievement average duration time working on the exam before redesigned was 109.67 and after redesigned was 85.33. Both test result was different meaningful with value p<0,05. The test value average before the redesigned was 59.60±4.05 and after redesigned was 82.53±3.87. Both test result was different meaningful with value p<0,05. Related to duration time working on the exam and test value result, the increase in study achievement after the redesigned is 22%, and the time efficiency work increased 38.5

The study achievement was influenced by temperature, lighting and anthropometry of practicum. Research result Anita (2005) is, that affects the learning outcome is the temperature. Wibowo (2010) says there is the influence of anthropometry on the fatigue of work and learning outcomes.

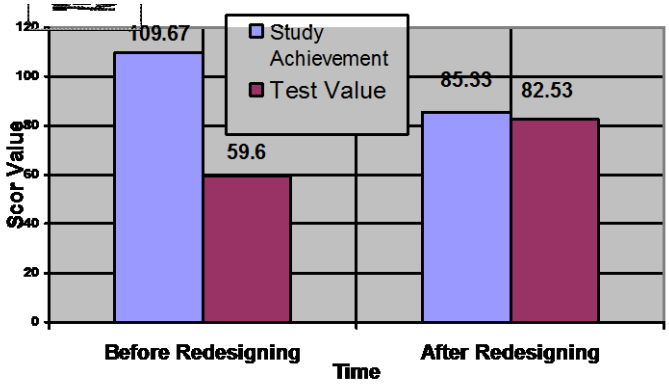

Figure 5. The Student Achievement Before and after Redesigning of the Computer Laboratory

Performance Improvement a Subject

The performance average score before redesigned was 59.72±25.19 and after redesigned was 44.81±31.65. Seeing from the obtained performance result there was a significant decrease with p<0,05 meaning that there was subject performance increase. Increased the performance after redesigned reached 25%.

Performance increase reached since the work condition at computer laboratory has been redisigned that the work place condition was felt to be more standard. This condition can influence the subject study achievement, witnessed with study achievement scored by time efficiency achieved from 22% and achievement increase 38.5%. Performance increase reached 25% from prior condition before redesigning. Pelilingan (2007) found that performance increase 48.704 – 80.03%. The difference of performance obtained by the research was caused by difference of characterisctic of work an dfactor used to express performance.

Efficiency of the Electric of Power increase

The recounting was intended to obtain temperature condition and lighting in accordance with optimal condition. Increase in the use of electric power that results in the increase in performance. The increase of performance that seen from included decrease of eye fatigue, general fatigue, musculoskeletal complaint, stress, work load and the subject's study achievement. Comparison between performance and the use of electric power before and after redesigned contributed to efficiency. From the comparison between performance and the use of electric power before and after the redesining resulted in efficiency 65%. Lilik's finding (2010) resulted in an increase in efficiency of the use of electric power 44.74% and 107.89%. The diference is caused by condition and research object used.

Efficiency 65% obtained, showed that there was an increase in completion of exam earlier faster time 22% from the time standard determined.

Novelty

The new findings in this study were:

Design laboratory computer is based ergonomics namely :

1) Improvements on temperature and light intensity;
2) Repair high chair;
3) Repairs the distance a table by a table
4) Adjustment of the color of curtains
5) Electrical energy use efficiency

Conclusion

From the above discussion, the conclusions can be drawn are:

1. Redesigning computer laboratory that ergonomics at Electrical Engineering Department Udayana University can decrease eye fatigue
2. Redesigning computer laboratory that ergonomics at Electrical Engineering Department Udayana University can decrease general fatigue
3. Redesigning computer laboratory that ergonomics at Electrical Engineering Department Udayana University can decrease musculoskeletal fatigue.
4. Redesigning computer laboratory that ergonomics at Electrical Engineering Department Udayana University can increase studying achievement.

5. Redesigning computer laboratory that ergonomics at Electrical Engineering Department Udayana University can increase student performance
6. Redesigning computer laboratory that ergonomics at Electrical Engineering Department Udayana University can increase electric power efficiency.

Recommendations the that can be conveyed to those who intensively conduct research related to field of health particularly ergonomics are.

1. Ergonomics through the approach of S.H.I.P. proved to be used in solving problem comprehensive, therefore ergonomics solution solving can not be done partially in order that the solution will not result in other problems future.
2. The researchers who are interested in the field of redesigning would be expected to use the ergonomics the total to redesign work palce at their work environment by using light intensity of other colors, since have not been used in this research

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