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VDT WORKPLACE DESIGN AND EFFECTS ON MUSCLE DISORDERS AND EYE STRAIN AMONG STUDENTS AT AN EDUCATIONAL INSTITUTE

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By

ZINAH MUAYAD KHALEEL

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Master of Science

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DEDICATION

"And they ask you about the Spirit. Say: "The Spirit by command of my Lord: and you are not given aught of knowledge but a little."
(Al-Quran Al-Kareem, Surat Al-Israa, 85)

Every challenging work needs self-efforts as well as the guidance of elders especially those who are close to our heart. Whose affection, love, encouragement and praise for day and night make me able to get such success and honor and the reason of what I become today. My humble effort I dedicate to my sweet and loving

Father & Mother
Who have always been my epitome of strength.

My Husband (Muhammad)
Who has been very understanding and patient.

My kids, Huthaifa & Adam
My Family, My Siblings

I am really very grateful to all of you.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

VDT WORKPLACE DESIGN AND EFFECTS ON MUSCLE DISORDERS AND EYE STRAIN AMONG STUDENTS AT AN EDUCATIONAL INSTITUTE

By

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Chairman : Professor Rosnah binti Mohd Yusuff, PhD
Faculty : Engineering

The advancement of information technology encouraged schools, universities and other educational institutions to use visual display terminal (VDT) in conducting lectures rendering services and developing various systems. The use of personal computer (PC) and laptops are common among students. Classrooms are equipped with liquid crystal display (LCD) screens for lecturers to display their lectures for students. Many cases have not been reported because of lack of awareness and understanding on ergonomic. However, Poor ergonomics of the physical environment of VDT can cause musculoskeletal disorders (MSDs); the inappropriateness of school design may influence student achievement negatively. The viewing distance and position of the screens have been found as the main factors causing MSDs. The students' satisfactions on VDT used in the education institute were determined. The effects of VDT workplace design parameters on muscle disorder and eye strain among students were determined. Ergonomically positions of VDT for safer and comfortable use among students were proposed. Data obtained from 215 LCD projector users and 103 desktop monitor users were analyzed using frequency tables, one sample t-test and Spearman's rank order correlation coefficient. The frequency analysis for the level of satisfaction among LCD projector users showed that most of the users (88.4%) were satisfied with the viewing distance, and were least satisfied with the lighting(51.6%). For the monitor user, the users were highly satisfied with user/ screen position (80.6%) and least satisfied with the viewing distance (61.2%). Most of the LCD projector users (36.7%), experienced eye pain while performing study tasks on the projector screen, and the least pain were for head pain (22.8%). Most of the desktop monitor users (54.9%) were experienced head pain while performing study tasks on the monitors, and only (32%) experienced back pain. The relationship between the level of satisfaction for physical environment and MSDs was determined using Spearman's rank order correlation coefficient. Results showed that, there were a significant and

negative relationship between satisfaction of lighting and the level of back pain (r_s = - 0.213, $p < 0.001$), head pain (r_s = - 0.266, $p < 0.001$), neck pain (r_s = - 0.119, $p < 0.034$) and eye pain (r_s = - 0.292, $p < 0.001$) levels. Significant relationships were found between the level of distance satisfaction and the level of back pain (r_s = - 0.148, $p < 0.01$) and eye pain (r_s = - 0.151, $p < 0.04$). The results of association between satisfaction of position and MSDs pain indicated that only the relationship between satisfaction of position and the eye pain (r_s = - 0.151, $p < 0.005$) was significant and negative. The results implied that the eye is the part of the body which is affected by all the other variables (lighting, distance, and position), but particularly more affected by problems with lighting in the study hall. In conclusion, this study has demonstrated that there is a lack of satisfaction with respect to some items within the physical environment, and there were MSDs disorders associated with VDT use, especially the lighting. These all likely to play a significant role in affecting the user's health, and subsequently their performance. Thus providing enough lighting sources above the students and nearby the (monitor/ p- screen), added to the windows in the classrooms and libraries. Also, ensure the proper distance like an arm's length for monitor users and (2 to 10) meters for the presentation screen users added to the students position directly in front of the monitor or p- screen with considering the study hall design (sloped or flat) to provide viewing angle (0° to -20°), which allow the students to read the text at or slightly below eyes level, all of those are suggested to reduce the MSDs among UPM students.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

REKA BENTUK VDT TEMPAT KERJA DAN KESAN KE ATAS GANGGUAN OTOT, KETEGANGAN MATA DAN KEPUASAN PELAJAR DI UPM

Oleh

ZINAH MUAYAD KHALEEL

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Faculty : Kejuruteraan

Kemajuan teknologi maklumat mendorong sekolah, universiti dan institusi pendidikan lain untuk menggunakan terminal paparan visual (VDT) dalam menjalankan khidmat rendering kuliah dan membangunkan pelbagai sistem. Penggunaan komputer peribadi (PC) dan komputer riba adalah perkara biasa di kalangan pelajar. Bilik darjah dilengkapi dengan skrin paparan kristal cecair (LCD) untuk pensyarah untuk memaparkan kuliah mereka untuk pelajar. Ramai kes tidak dilaporkan kerana kurang kesedaran dan pemahaman tentang ergonomik. Walau bagaimanapun, ergonomik Miskin persekitaran fizikal VDT boleh menyebabkan gangguan muskuloskeletal (MSD); ketidaksamaan reka bentuk sekolah boleh mempengaruhi pencapaian pelajar secara negatif. Jarak paparan dan kedudukan skrin telah dijumpai sebagai faktor utama yang menyebabkan MSDs. Kepuasan pelajar terhadap VDT yang digunakan dalam institut pendidikan telah ditentukan. Kesan dari parameter reka bentuk tempat kerja VDT pada gangguan otot dan ketegangan mata di kalangan pelajar telah ditentukan. Kedudukan ergonomis VDT untuk penggunaan yang lebih selamat dan selesa di kalangan pelajar dicadangkan. Data yang diperoleh daripada 215 pengguna projektor LCD dan 103 pengguna monitor desktop dianalisis menggunakan jadual kekerapan, satu sampel ujian t dan pekali korelasi pesanan peringkat Spearman. Analisis kekerapan bagi tahap kepuasan di kalangan pengguna projektor LCD menunjukkan bahawa kebanyakan pengguna (88.4%) berpuas hati dengan jarak tontonan, dan kurang berpuas hati dengan pencahayaan (51.6%). Untuk pengguna monitor, para pengguna sangat berpuas hati dengan kedudukan pengguna / skrin (80.6%) dan kurang berpuas hati dengan jarak tontonan (61.2%). Kebanyakan pengguna projektor LCD (36.7%), kesakitan mata yang berpengalaman semasa menjalankan tugas kajian pada skrin projektor, dan kesakitan paling sedikit adalah untuk sakit kepala (22.8%). Kebanyakan pengguna pemantau desktop (54.9%) mengalami kesakitan kepala semasa menjalankan tugas kajian pada monitor, dan hanya (32%) mengalami sakit belakang. Hubungan antara

tahap kepuasan untuk persekitaran fizikal dan MSD ditentukan menggunakan pekali korelasi pesanan peringkat Spearman. Keputusan menunjukkan bahawa terdapat hubungan yang signifikan dan negatif antara kepuasan pencahayaan dan tahap sakit belakang (rs = - 0.213, p <0.001), sakit kepala (rs = - 0.266, p <0.001), sakit leher (rs = - 0.119, p <0.034) dan tahap kesakitan mata (rs = - 0.292, p <0.001). Hubungan yang ketara didapati antara tahap kepuasan jarak dan tahap sakit belakang (rs = - 0.148, p <0.01) dan kesakitan mata (rs = - 0.151, p <0.04). Keputusan hubungan antara kepuasan kedudukan dan kesakitan MSD menunjukkan bahawa hanya hubungan antara kepuasan kedudukan dan kesakitan mata (rs = - 0.151, p <0.005) adalah signifikan dan negatif. Hasilnya menunjukkan bahawa mata adalah bahagian tubuh yang dipengaruhi oleh semua pembolehubah lain (pencahayaan, jarak, dan kedudukan), tetapi terutamanya lebih terjejas dengan masalah pencahayaan di dewan belajar. Kesimpulannya, kajian ini menunjukkan bahawa terdapat kekurangan kepuasan berhubung beberapa perkara dalam persekitaran fizikal, dan terdapat gangguan MSD yang berkaitan dengan penggunaan VDT, terutama pencahayaan. Ini semua mungkin memainkan peranan penting dalam menjejaskan kesihatan pengguna, dan seterusnya prestasi mereka. Oleh itu menyediakan sumber pencahayaan yang mencukupi di atas pelajar dan berdekatan (monitor / p-screen), ditambah kepada tingkap di bilik darjah dan perpustakaan. Juga, pastikan jarak yang sepatutnya seperti panjang lengan untuk pengguna pemantau dan (2 hingga 10) meter untuk pengguna skrin persembahan yang ditambah kepada kedudukan pelajar secara langsung di hadapan monitor atau skrin dengan mempertimbangkan reka bentuk dewan pengajian (sloped atau flat) untuk menyediakan sudut tontonan (0 ° hingga -20 °), yang membolehkan para pelajar membaca teks pada atau sedikit di bawah paras mata, semua yang dicadangkan untuk mengurangkan MSD di kalangan pelajar UPM.

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This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

MSDs	Musculoskeletal disorders
VDTs	Visual display units
VDU	Visual display units
CRTs	Cathode Ray Tubes
NIOSH	National institute for occupations safety and health
CVS	Computer vision syndrome
PCs	Personal computers
PDAs	Personal digital assistants
OSHA	Occupational safety and health administration
HCI	Human computer interface
SWEA	Swedish work environment
Lux	Illuminance
LCD	Liquid crystal display
ICT	Information and communication technologies
IWBs	Interactive whiteboards
FITS	Name of model
ISo	International organization for standardization
AS	Australian standards
CFF	Critical fusion frequency, critical ticker frequency
TFT-LCD	thin-film-transistor liquid-crystal display
PDPs	plasma display panels
FHP	Forward head posture
HUD	Head- up display
HDD	Head- down display
UPM	Universiti putra Malaysia
ANSI/ IESNA	American National Standards Institute Illuminating Engineering Society of North America
SS- EN	Singapore Standards eShop
OR	Odds ratio
IT	Information technology
p- screen	Projection screen

SPSS	Statistical Package for the Social Sciences
BMI	High body mass index
WHO	World Health Organization
SD	Standard division
DV	*Depended variables*

CHAPTER 1

INTRODUCTION

The rapid development of digital science and technology has brought the VDT to the forefront of teaching aids. Personal computer and LCD projector users have increased immensely in both schools and companies, and more people are now relying on VDT in order to brief plans, present papers, demonstrate products, hold meetings and conferences as well as a teaching aid.

Personal computer and LCD projectors have become commonplace in different work and teaching/learning environments (Cheng et al., 2015). While the Cathode Ray Tube (CRT) was almost always used in computer displays in the early days of the computer, technological advances have now made it possible for the introduction and use of several types of different displays (Tannas, 2012).

An important environment in which the display monitor is used daily is in the university. As such, students will be affected by any problems which may occur with screen ergonomics and which lead to poor human-machine interface. A combination of factors determines the readability in lecture halls and classrooms. As computer uses are visually demanding, the result can be vision problems and their symptoms. Most of the research done in this area has indicated that office workers who use computers are prone to eye-related problems while non-computer using workers do not experience such problems (Woodson et al., 1992).

Some studies (Hayes et al., 2007; Ranasinghe et al., 2016), have reported visual symptoms occurring in 75 to 90% of computer workers. On the contrary, the National Institute for Occupational Safety and Health (NIOSH) indicated that only 22% of computer workers suffer muscular disorders (Smith et al., 1981; Collins et al., 1991). Optometrists surveyed have stated that in excess of 10 million primary care eye examinations are carried out every year in one country, mainly due to visual problems resulting from computer use. This led to a compilation of symptoms now referred to as Computer Vision Syndrome (CVS). This condition happens when the visual ability of the computer user is unable to cope with the viewing demand of the task (Kiekenapp, 1926). The American Optometric Association describes CVS as that "complex of eye and vision problems related to near work that is experienced during or related to computer use." There are different symptoms exhibited but generally include eyestrain, headaches, blurred vision (distance or near), dry and irritated eyes, delayed refocusing, neck and backache, unusual sensitivity to light, double vision, and colour distortion (Sheedy, 1992).

1.1 Problem Statement

The rapid advances in digital science and technology have elevated the computer and digital projector to a level of great significance as teaching aids (Wu et al., 2007; Wu et al., 2011). Computer users, especially students, often perform prolonged seated tasks that involve focusing on a computer screen that could lead to a static head-neck posture and sustained muscle activity all of which also increase the likelihood of developing musculoskeletal pain, loading and visual fatigue (Tamrin et al., 2016). There is an increase in complaints of neck-shoulder pain following the use of computer screen (Legg et al., 2015; Scuffham et al., 2010).

Poor ergonomics of the physical environment of VDT can cause musculoskeletal disorders (MSDs), The inappropriateness of school design may influence student achievement negatively(tanner,c. k. (2008)..However , many cases have not been reported because of lack of awareness and understanding on ergonomic (Mohd Yusuff et al .,2016) . Hence , it is imperative for researcher to focus on studying this phenomenon as the occurrence of MSD and eye pain has become avital issue , especially for the student .

1.2 Objectives

1.2.1 The objectives of this study are:

1. To determine the students' satisfaction on VDT used in the education institute.
2. To determine the effects of VDT workplace design parameters on muscle disorder and eye strain among students.
3. To propose ergonomically position of VDT for safer and comfortable use among students.

1.3 Research Scope

This research focuses on the students' satisfaction with VDTs in four faculties, three complexes and three libraries in UPM as an example of an educational institute and whether they are suffering from any health disorders because of using VDTs, such as muscle disorders or eye strain. Also, this study investigates the relationship between the MSDs and eye strain and the lighting, viewing distance and student's/screen's position.

The data was collected from different physical environments to ensure greater understanding of the students' performance in different study conditions, such as different screen sizes, different viewing distances, and different positions. The participants included students of sexes, different age groups, nationalities, and different levels of study. This current research investigated how they were affected

by the use of desktop monitors and projectors and how their health was threatened regardless of their gender age, nationality, or study levels. the findings are generally useful for all other educational institutes.

1.4 Thesis Outline

Chapter 1 of this thesis identifies and presents the Problem Statement, Objectives, and Scope of this research. Chapter 2 (literature review) covers relevant topics related to this work and also the background such as education ergonomics, the different kinds of VDT, MSDs and eye strain because of computer usage and the physical environment items, which may affect the student's performance such as the lighting, viewing distance and the student's/screen's position. Chapter 3 explains the data collection protocol, data preparation and proposed research methodology. Details of the results and discussion are provided in Chapter 4, while the conclusion of the current work and potential future investigations are presented in Chapter 5.

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LIST OF PUBLICATIONS

Journal

Zinah Muayad Khaleel, Rosnah bt. Mohd. Yusuff, Faieza bt. Abdul Aziz and Muhammad A.Fakhri. 2017. Computer- related eye pain: A case study from Malaysian public (UPM) for the effect of lighting on eye strain among university students. *Sci.Int.(Lahore)*. Volume 29. Issue 1. pp. 93–98. ISI. Published.

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