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ORIGINAL ARTICLE

WORKSTATION WITH ERGONOMIC FEATURES FOR UNIVERSITI KUALA LUMPUR MIDI CLASSROOM

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ABSTRACT

This paper presents a design process of workstation with ergonomic features for University Kuala Lumpur MIDI Classroom. The workstation is expected to support body posture, with the aim to increase comfortability of a user usage for long periods in a class. Besides that, the workstation will ensure a conducive and responsive learning environment. Discomfort and an improper position can negatively affect overall health and productivity. A new design of workstation, which allows user to sit in ideal sitting position suggested by ergonomist and easy transition from one teaching mode to the next. The researcher has designed and developed a new workstation which has ideal ergonomic sitting working position and capable accommodate 50th percentile human size. These positions were used to evaluate the comfort of the workstation. Subjective evaluations, including comparison of the prototype and standard workstation setup, were carried out using human subjects and ergonomic principles. Result showed that the new workstation is much more comfortable, supporting the body in a balanced way. Users have the freedom to stretch and relax in different working positions before they feel any noticeable discomfort. As a result, it lets user sit for a longer period without strain, thus resulting in higher productivity and concentration in classroom.

Keywords *Ideal sitting position, subjective evaluation, higher concentration, improper position*

INTRODUCTION

Most all colleges, institutes or universities are having classrooms furniture, but this furniture is low of comfort level to students since anthropometric data were not considered in the initial stage of designing furniture. Anthropometric measurements whenever be considered for designing, it helps students achieve comfortability level, reduce Musculoskeletal disorders (MSDs), and improve performance of students in terms of attentiveness while professors or instructors are teaching them[1].

In Malaysia, many ergonomic improvements tend to focus on industrial and occupational setting, but it is lacking in universities environment. In fact, in university environment, ergonomic assessments are not in existence. In addition, currently no record of university (infrastructures such as building, layout, classroom, and the university student) is designed or build on application of ergonomics[2].

In universities, the use of computers and electronic systems has increased exponentially in the last decade leading to a marked increase in the number of hours student spend on computers. Academic core activities of teaching and learning are increasingly being conducted using computing software and the internet, that lead to sitting for long hours with potentially deleterious health effects. Prolonged computer use is recognised as an occupational risk factor for musculoskeletal disorders[3].

Different postures have an impact on performance, but further experiments with improved fixtures should be done. This research focuses on the study area at University of Kuala Lumpur MIDI. Preliminary study was conducted and the results show that 77.4% of the student participated in the study are not comfortable with the current classroom furniture that leads to muscular disorder, and 81.1% agreed with the idea of making improvement on ergonomic features of the furniture design.

In this research, a new workstation capable of offering working positions that follow the posture of a user is proposed in order to increase comfort and concentration. Thus, the objectives of this research were:

(1) to determine the prevalence of Musculoskeletal disorders (MSDs) rating in university and its relationships to workstation configuration.
(2) to design a new workstation with ergonomic features that fit student anthropometry data.

Figure 1 shows the proposed design of the workstation.

Figure 1: Proposed workstation design.

METHODS

Design

1. Ergonomics design of the workstation

The design concept was based on the ergonomics problem of the current existing workstation. Therefore, the furniture must be designed to reduce static posture, awkward posture (bending, bending and twisting, bending of the neck and shoulder) and equally match with the anthropometry of the students.

The workstation interacts with the user. Thus, the design of this interaction determines the comfort and performance of the user. The ergonomic design mainly focused on angle of the sitting position to encourage 'Upright Postures' as ideal sitting position suggested by ergonomist[4]. While sitting, people have a tendency to change positions for example, extending or bending legs, extending or bending arms, leaning back or forward, etc. However, the common standard chair doesn't allow such kinds of position change due to its inflexible design. Nonetheless, users try to change positions as much as possible. This attempt leads to an improper sitting posture, which results in pain.

Moreover, the shape and form of each part were also considered in the design procedure. The simple silhouette and minimalist aesthetic makes the seating ideal for both commercial or residential spaces. The workstation made up from 2 simple tube components, forming the backrest and legs. The aesthetics and the space occupied by the whole workstation were also taken into account during the design. Therefore, a new design of the workstation was designed to have simple and effective mechanisms that efficiently provide proper comfort to all body parts.

2. Dimensioning

The overall workstation and each part were designed to meet ergonomic features so that the workstation could accommodate different sizes of people. The anthropometric data use in this research are obtain from Anthropometric of Malaysian Young Adults in accordance with Malaysian Standard MS ISO 7250, Basic Human Body Measurements for Technological Design since the data are free and for public use[5].

The dimensions of each part of the workstation were determined based on the minimum and maximum value of anthropometric data of 50th percentile male human size measurements. In the same manner, anthropometric weight data was used to determine the load applied on the workstation for force and strength analysis. The workstation was designed based on the mass of the upper limit of 50th percentile male user. So, the workstation could accommodate average percentile human size[2].

3. Product Design Specification

The PDS is a document that contains all of the facts related to the outcome of the product development. It should avoid forcing the design direction toward a particular concept and predicting the outcome, but it should also contain the realistic constraints that are relevant to the design. Creating the PDS finalizes the process of establishing the customer needs and wants, prioritizing them, and beginning to cast them into a technical framework so that design concepts can be established. The process of group thinking and prioritizing that developed the HOQ provides excellent input for writing the PDS.

4. Quality Function Deployment

Quality Function Deployment (QFD) is a structured approach to defining customer needs or requirements and translating them into specific plans to produce products to meet those needs. The "voice of the customer" is the term to describe these stated and unstated customer needs or requirements. The voice of the customer is captured in a variety of ways: direct discussion or interviews, surveys, focus groups, customer specifications, observation, warranty data, field reports, etc. This understanding of the customer needs is then summarized in a product planning matrix or "house of quality".

These matrices are used to translate higher level "what's" or needs into lower level "how's" - product requirements or technical characteristics to satisfy these needs. While the Quality Function Deployment matrices are a good communication tool at each step in the process, the matrices are the means and not the end. The real value is in the process of communicating and decision-making with QFD. QFD is oriented toward involving a team of people representing the various functional departments that have involvement in product development: Marketing, Design Engineering, Quality Assurance, Manufacturing/ Manufacturing Engineering, Test Engineering, Finance, Product Support, etc.[6].

Evaluation Method

1. Prevalence of MSDs

A set of questionnaires was distributed to the respondents. The questionnaire session was conducted in online survey website at docs.google.com/forms. Each student was briefed on the correct procedure of completing the questionnaire. The respondents answered all the questions without the supervision and guidance of researcher. The questionnaire includes socio-demographic and background information such as gender, age, and studied programme. The MSD questions include 9 body parts and the overall MSD (any MSD symptoms at any body parts).

The body parts include neck, shoulder, elbow, arm, upper back, lower back, hip and thigh, knee, leg and overall MSD. Fig. 2 shows the evaluation on existing workstation. Questions were given to students to ascertain the level of severity between lifetime prevalence and within 7 days for acute MSD. Other than that, the student was also asked regarding their perception whether the existing furniture is the factor of reported pain complained.

Figure 2: Evaluation on the existing workstation

2. Real-Time User Comfort (RTUC) Evaluation

RTUC is a subjective evaluation method. In this evaluation, a subject used the current furniture and the prototype workstation that will developed to evaluated and comparable the comfortable of the design. Means, the evaluation will take part before the development to prove the MSD rating on existing furniture and after the development to prove there is an improvement on develop design. Participants were instructed to perform their own tasks freely, as they would do at their own personal activity, for two continuous hours in the classroom to make the experience as real as possible. They were also advised to change working positions from one position to another, as necessary. After completion, participants rated their comfort on a questionnaire Figure 3. Results of the prototype were compared against the results of the existing furniture design to see the difference.

The evaluation was carried out by recruiting 8 student subjects (four males and four females). Attempts were made to include a mixture of participants of different gender, age, and size. Preference was also given to people who spent longer periods of time sitting at classroom. All participants were mentally and physically healthy, with a normal body mass index (BMI)[7].

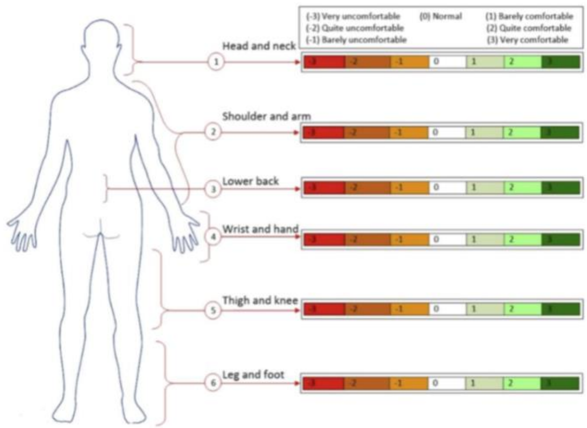

Figure 3: Questionnaire of RTUC Evaluation[7]

RESULTS

In determining the factors of MSDs among the student, Musculoskeletal complaint of within the last 7 days and previous 12 months was used that indicated the factor developing the MSDs. The study revealed in Table 1 that for life time prevalence of MSD (very uncomfortable), 31 of the student reported they had lower back pain (LBP) once in a life time followed by 26 of the student reported that they had head and neck pain (HNP). Arm pain (SAP) 23-person, wrist, and hand pain (WHP) 22-person, thigh and knee pain (THP) 20 person and 19 of them reported leg and foot pain (LFP) at least once in their lifetime. The result also indicated that the main factor of reported pain complained are strongly agree by respondent (77.4%) because of the existing workstation design.

***Table 1**: Lifetime Prevalence of MSDs*

Body Parts	Very Uncomfortable	Quite Uncomfortable	Barely Uncomfortable
HNP	26	21	8
SAP	23	23	9
LBP	31	18	6
WHP	22	25	8
THP	20	25	10
LFP	19	26	10

*noted that the values show number of student.

After completion test on the existing workstation, the RTUC test was conduct on the two version of prototype using the same test subject Figure 5). This is to ensure the result of the test are consistent. Test subject also performed the same task using standard setup and rated their comfort on the same questionnaire. Results of the prototype were compared against the results of the existing workstation to see the difference.

DISCUSSION

The test revealed that there was a significant impact on comfort of each body part based on the workstation setup Figure 4. There was a significant change in comfort of the head and neck due to workstation setup (from -3 to 1). Similarly, a significant change in comfort value of the shoulder and arms legs and feet was shown due to workstation setup (from -3 to 1). However, no significant effect due to workstation setup was indicated in comfort of wrist and hand (increased to 2).

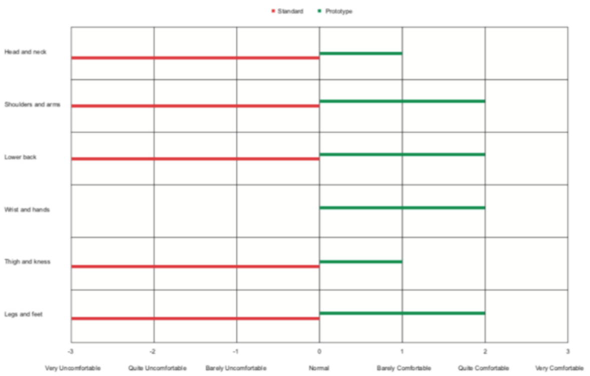

Figure 4: RTUC evaluation results comparison

A pairwise comparison of the comfort values by body parts revealed that upper body comfort was rated significantly better than the lower body parts on the prototype. Participants performed their own personal work as they would do on their personal workstation. Participants were noticed to be changing working positions frequently which was in every 20 minutes slightly longer that existing workstation (every 10 minutes average), on average. Since testing of the prototype was carried out prior to this evaluation procedure, participants were able to change the sitting position without difficulty. Figure 5 show several sitting configuration through out the evaluation.

Results showed that there was no discomfort during working on the prototype workstation; comfort scales for all parts were above the "normal" comfort scale. On the other hand, half of body parts (head, neck, lower back, thigh and knees) exhibited discomfort (very uncomfortable <0) during working on the existing workstation. The buttock-rest of the prototype improved comfort of the head, neck, shoulders and arms (increased to 1 and 2). The results of the lower back comfort (increased from -3 to 2) indicated that the buttock-rest of the prototype provided great comfort for the lower back, which is usually the sensitive area to feel pain during static work. Lower body parts (thighs, knees, legs and feet) experienced quite comfortable (increased to 1 and 2) during working on the prototype. In another evaluation of comfort of the prototype parts, the lower back registered the highest comfort value change. It shows the consistency of results. The buttock-rest created big difference in the comfort of lower parts of the body.

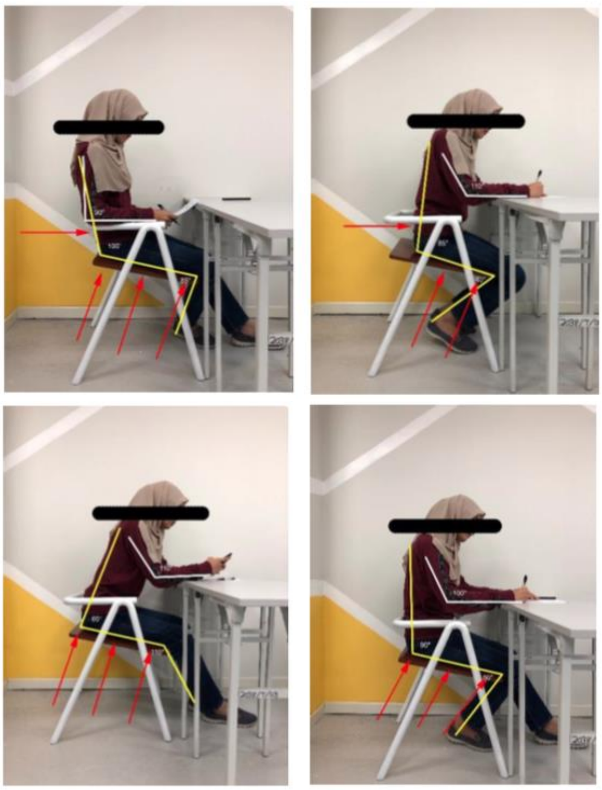

Figure 5: RTUC evaluation on prototype

CONCLUSION

In the development of the workstation, the industrial design process was integrated with ergonomics concept in order to produce new workstation with ergonomics features for university. The industrial design process was based on ergonomics problem and safety identified in the classroom and it comprised of proposing design concept followed by developing mock-up model and fabricating of prototype. In order to increase the comfort and reduce the ergonomics problem, the workstation was designed based on Malaysian young adult anthropometrics dimension. The criteria were set up to fit 95% of student and to reduce the flexion of neck, upper back and shoulder during writing and reading. In an attempt to understand the severity of MSDs among student at Universiti Kuala Lumpur MIDI, a preliminary study was done to determine the prevalence of MSDs using Real-Time User Comfort (RTUC) Evaluation. The evaluation studies on the effectiveness of prototype included posture analysis and sitting movement. The evaluation study of prototype indicated that the RTUC score was increased from more than maximum -3 to more than 1. This indicated that the new proposed workstation was able to reduce the risk from un-ergonomic workstation.

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COMPETING INTERESTS

There is no conflict of interest.

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