Mismatch between Anthropometric Body Dimensions and Classroom Furniture in Malaysian Universities

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Abstract –The main objective of study is to highlight possible mismatch between the student's body dimensions and the dimensions of classroom furniture used in most Malaysian universities. This issue is pertinent due to the notable increase in the number of international students who are enrolled in Malaysian universities each year. The matching of body dimensions and classroom furniture is vital to promote proper sitting posture. Body dimensions of the people from the few different countries that are perceived to make up the current student's population in Malaysia are measured against dimensions of prevalent chairs and desks used in the classroom. The sample case study is done in Faculty of Engineering, Universiti Putra Malaysia but it is believed that the derived conclusion can also be extended to other universities in Malaysia. All in all, several mismatches have been found and highlighted for a better planning and design of classroom furniture.

Keywords: classroom furniture, Malaysian universities, body dimensions

1. INTRODUCTION

Students spend at least several hours a day at university campus and most of the time they are working in a sitting position in their classroom. Many tasks are done a seated position – using laptop, writing and reading are several examples of task that are performed daily by students in class. Considering the amount time they spend sitting in the classroom, it is important to have suitable furniture that appropriately supports their body in performing those tasks. Otherwise, they may suffer fatigue and back pain for sitting in an uncomfortable position for a long period of time. In addition, proper design of classroom furniture reduces muscular disorder and greatly helps to increase student's concentration during their lectures or study.

Ergonomic design of chairs in classroom is closely tied to anthropometric features of the students' population. It is believed that there is a growing mismatch between design feature of the furniture used in the classroom in many Malaysian universities and the anthropometric features of the students. Part of this problem can be contributed to the growing population of international students in Malaysian universities. It is clear that Malaysian or Asian students can have very different anthropometric features or body

dimensions compared to their international counterparts who might come from European or African countries.

To support this notion, a preliminary survey was done on 500 students from five different universities: Universiti Putra Malaysia (UPM), Universiti Kebangsaan Malaysia (UKM), Universiti Tenaga Nasional (UNITEN), Lim Kok Wing University and Universiti Malaya (UM). Students through the survey were asked if the dimensions of the current chair such as height is suitable for them based on their experiences in the classroom of their universities. The students were selected from different nationalities to represent the diverse background of the current student population in Malaysian universities nowadays. Summary of the participants' background in terms of their gender and nationality is shown in Fig. 1 and Fig. 2, respectively.

Fig. 1: Gender distribution of survey participants

Fig. 2: Nationality distribution of survey participants

It is concluded from the survey that most of the students were not happy with current chairs in their classroom. Some of the issues pointed out by them highlight design deficiencies of current furniture used. This survey result provides the necessary support to the notion that there are ongoing problems with design of chairs used in current classroom in many Malaysian universities and this is the solid background to future pursue this study.

2. ERGONOMIC PRINCIPLE OF CHAIR DESIGN

One of the main health issues in workplace is back pain, which leads to high medical costs and loss of efficiency in the work position. This is also true for students who are studying in their classroom furniture settings. According to physicians and researchers, they believe this common low back pain is not a disease. Based on the fundamental principles of seat design, it should not only support the spine but also the lumbar spine. The lumbar support in seat design will maintain the S-curve shape of the spine in sitting posture as in the case when we are in our standing posture. A proper seating posture should be comfortable and permit user's feet on the floor. Furthermore, it should not subject to much stress on the user's buttock back and/or arm.

In general, anthropometric data of the users can assist the designers in finding if there is a mismatch between their body dimensions and the design of the consumer products in order to reduce any discomfort that such situation may cause to users. As highlighted in Figure 3, static human physical characteristics data is usually measured with the subject in a seated and erect posture, with 90 degrees knee bent. The required human body dimensions to assess the design of a chair include 1. Stature, 2. Shoulder height, 3. Elbow height, 4. Sitting eye height, 5. Thigh thickness, 6. Abdominal depth, 7. Buttock-popliteal length, 8. Hip breadth, 9. Popliteal height, 10. Forearm.

In classroom setting, minimum and maximum shoulder angles for students while writing as being recommended by many ergonomists is 0-25° for shoulder flexion and 0°-20° is for shoulder abduction. The corresponding cosines are 1 (0°) and 0.9063 (25°) for flexion angles and the corresponding cosines are 1 (0°) and 0.9397 (20°) for abduction angles. Minimum and maximum desk height is determined by the following equations.

- Minimum desk height = seat height + hE
where $hE = hEv + U[(1-1) + 1(1-1)] = hEv$
- Maximum desk height = seat height + hE
where: $hE = hEv + U[(1 \cos \theta) + \cos \theta (1 \cos \beta)]$
 $hEv + U[(1 \cdot 0.9063) + 0.9603(1 \cdot 0.9397)]$
 $0.8517hEv + 0.1483 Hs$, since $U = hS - hEv$

When the height of the desk is shorter than the minimum desk height or higher than the maximum desk height, it is defined as mismatch of elbow-shoulder height and desk height.

Fig. 3: Measurement of static human physical criteria
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3. CASE STUDY

To study whether there is a current mismatch between the classroom furniture in most universities in Malaysia and the students' body dimensions, an example case study is done by examining the classroom facilities in Faculty of Engineering, Universiti Putra Malaysia.

Methodology

The summary of steps taken in the execution of this case study is shown in Figure 4. First, physical anthropometric data to represent the different nationalities of the student population is searched in the public literatures. Next, all the required data and parameters for the comparison are identified. Related standards and relationships about the design ergonomics are studied and become the basis for the comparison. Dimensions of current furniture available in the classroom are then measured and the corresponding values of anthropometric features to represent the student population are analyzed and extracted from the reference published data. After that, the comparison between the furniture dimensions and representative anthropometric

data is done. Based on the results of the comparison, any existing mismatches can be identified.

Fig. 4: Flowchart of the methodology

Results of Case Study

Table 1 summarizes the anthropometric data obtained to represent current students' population within the Faculty of Engineering, University Putra Malaysia.

Table 1: Anthropometric data for the students

Female	N	StDev	Mean	Mode	Median
WEIGHT	170	9.967	0.764	50	52.000
HEIGHT	170	6.27	159.29	160	159.00

Male	N	StDev	Mean	Mode	Median
WEIGHT	170	14.46	70	50	68.00
HEIGHT	170	14.46	180	160	173.00

Meanwhile measurements of the chair and desk available in the classroom of the Faculty of Engineering, Universiti Putra Malaysia are depicted in Fig. 5, Fig. 6 and Fig.7.

Fig. 5: Desk Dimensions

Figure 6: Dimensions of chair (side view)

Fig. 7: Dimensions of chair (front view)

All in all, comparison between students' anthropometric data and design dimensions of the classroom furniture is summarized in Table 2. It can be observed that there exist several mismatches based on the ergonomics standard for furniture design.

Table 2: Table of comparison

Chair Requirements	Anthropometric Measurement	Chair Dimensions	Body Dimensions
Seat height	Popliteal Height+ Shoe Measure	41.50	38
Seat Depth	Buttock popliteal Length_ Clearance Measure	41	42
Seat Width	Hip Breadth in sitting posture+ Cloth Measure	40	41.26
Seat pan angle	-----	0.8	0.5
Backrest height	-----	50.50	49.08
Desk Height	Seat height+elbow height	76	38+28 = 66

In order to remedy this situation, suggestions on the new dimensions are as follows:

- Chair seat depth is 41 and it should be 42 according to new anthropometric dimensions
- Seat width and hip breadth mismatch: the current seat width is 40 and it should be changed to 41.26 cm
- Desk height and elbow height mismatch from sitting surface: The real height of desk used in university is

76 and we mines 41.5 cm as the seat height to find the desk height from sitting surface. The amount is 34.5

- According to formulas for minimum and maximum chair height I obtained 17.73 and 25 respectively. It is recognized that 9.5 cm is mismatch
- Backrest height and shoulder height mismatch: Based on the ergonomists it should be adopted with 95th shoulder height of male and is 64.08 in my survey. However, the backrest of current educational chair in university of Putra is 92 cm. There is 28 cm mismatch.
- Gap between backrest and desk: It should be measured based on the average of 5th percentile of female to 95th percentile of male abdominal depth. In my data I obtained it 28 cm. As we can see this gap is different in classroom decoration for individuals and the desk is too heavy to move and not easy to adjust the height of desks for per students based on his/her own body dimensions to be more comfortable when writing or working with laptops.

4. CONCLUSION

Data obtained from anthropometric dimensions indicates that there are a lot of differences even between people of the same race and nationality differences who make up the population of students in universities across Malaysia. The purpose of this study is to find the mismatch between the anthropometric dimensions and the current furniture used in classrooms of universities in Malaysia. Faculty of Engineering, Universiti Putra Malaysia is selected as the sample case study. From the comparison result, several mismatches are found and this leads to the conclusion that the design of furniture used in the classroom needs to be improved to better accommodate the studying process of the students. The scenario can also be extended to other universities in Malaysia.

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