ORIGINAL ARTICLE

A STUDY ON USER'S COMFORT LEVEL AND SEAT MISMATCH IN A LECTURE THEATRE

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ABSTRACT

The furnishings provided by the Institute of Higher Learning (IHL) are not suitable with the diverse student's body shapes. This could leads to lack of comfort in usage of the furnishings as well as affecting the effectiveness of the delivery of the lectures. Therefore, the objectives of this study are to evaluate the student's comfort level in the current seat of the Lecture Theatre (LT) and to gather student's anthropometry data. Two hundred and twenty one students were involved in this study from one of the IHL in Selangor. A few similar design of LT were chosen for this study. The Standard Nordic Questionnaire was used to identify the comfort level of students. Eleven body parts measurements of all participated students were collected by using measurement apparatus such as callipers and ruler. Based on the findings, it showed that the current seat in LT is uncomfortable to be used, in line with the results from surveys and mismatch of the seat and student measurement data.

***Keywords**: Anthropometry, student, seat, lecture theatre, comfort*

INTRODUCTION

The usage of lecture theatres (LTs) is a norm for every higher education institution students. There are various types of LTs provided by the Institute of Higher Learning (IHL) to ensure that they satisfies the requirement of their students. Numerous facilities were provided in LTs in order to achieve maximum satisfaction for the students during their learning session. However, due to the nature of diverse usage of LTs based on the assortment of activities of each subjects, there is not a single LT can be acknowledged of having the perfect design to satisfy each activities of all of the subjects[1-4].Usually, the design and equipment in an LT only caters for basic facility requirements for a student such as furniture (chairs and tables), teaching aid (whiteboards, screen, and projector), air conditioning unit, fan etc. The selection of furniture and facilities plays an important role to ensure the learning process can be carried out with good effects. The arrangement style of an LT could potentially affects the student's learning, either positive or the opposite[5,6]. Attention must be given to the furniture's design such as tables and chairs since these two are the main objects used by students in LT. The typical students would utilise these two items for a long period of time, approximately 8.5 hours per day in a Malaysian IHL. While in lectures, students would usually sit in a fixed position for a long period. The achievement of the students are affected by the way an LT is prepared. One of the factors involving preparation of LTs is the seating amongst others[7].

The furnishings provided by the IHL at times are not accommodate with the diverse student's body shapes. This could leads to lack of comfort when using the furnishings and affecting the effectiveness of the delivery of the lectures. Nimeyer[8] suggested that comfort that came from the perfection of an LT arrangement would have an impact on the student's achievement while using the LT. Distractions that coexist in an LT as such come from the arrangement of furnishings, teaching aids, LT design and furnishing designs are constant discussion topics in ergonomic research and is a health issue with Musculoskeletal Disorder (MSD) and Lower Back Problem (LBP). The main factor to MSD and LBP is the inability of an LT furnishings to suit the users. The measurement and design of the furnishings often are incompatible with the physical of the users (students). This could lead to deteriorating health as well as the performance of the students[9-22].

Figure 1 - Space in between rows of seats

Figure 1 demonstrates the incompatibility of the size in between students and the seats that is being used. Some of the students are forced to engage in an awkward and uncomfortable positions due to this issue. It reveals also the constrained space in between seats where the students are having difficulties sitting side by side or to walk in or out from their seats. Therefore, this study will evaluate the mismatch condition between student and current seat in the LTs and finally, will providing appropriate solution in order to solve this issue.

METHODS

This study was performed in one of the IHL in Selangor, Malaysia. The students in this IHL follows scheduled learning process in LTs, workshops and labs according to the suitability of the subjects. Each of the subject runs for at least one hour and the average of each students using these LTs are 40-50 hours per week. The seats that were provided to them are fixed and attached with a flip table, as depicted in Figure 1. The method used in this research is based on several technique. This research involves data that was gathered in the selected IHL in Malaysia, where 1401 students, at the current time of this study, were enrolled to their diploma programmes. The total data gathered were 15.7 percent which is 221 from the total number of students which consist of male and female students. This total population is deemed suitable to represent the whole batch of diploma students that utilises the seats provided in their LTs[23].

There were three different instruments used in this study, the comfort level data, student's body measurement data and seat measurement. All these instruments were based from previous studies in anthropometric fields[23-39]. In addition, the data was obtained through two questionnaires adapted from previous research related to this topic[23-43]. The comfort level data was used in order to understand the effect on the student's focus during lectures. The second instrument is the student's anthropometric data was used to evaluate and to compare seating arrangement and student's anthropometric data in order to identify its compatibility. Figure 2 illustrates 11 body parts of the students to be collected in this study. There are: 1) Chest width; 2) Standing height; 3) Sitting height; 4) Eye level height; 5) Shoulder height; 6) Hip height; 7) Arm length; 8) Hind thigh height; 9) Knee height; 10) Arm height and 11) Buttock width. The body measurement was obtained manually using measurement apparatus such as ruler, outer callipers, measuring tape and modified inner calliper. Most of the anthropometric data was obtained when the subjects in a seating position which makes up 9 out of 11 body parts measurement. The remaining two was taken during the subject is in standing position.

Then, the last instrument which is the measurement of the seating in LTs is to be used as comparison with the second instrument. There were six identified measurements. The seat measurements were obtained using steel ruler, measuring tape and Vernier calliper. All measurements were referred to previous studies that are related to incompatibility of seats and anthropometry measurements[44-48].The measurements of the seats are shown in Figure 3. Each measured seat parts were labelled based on required data for comparison with student's anthropometry data.

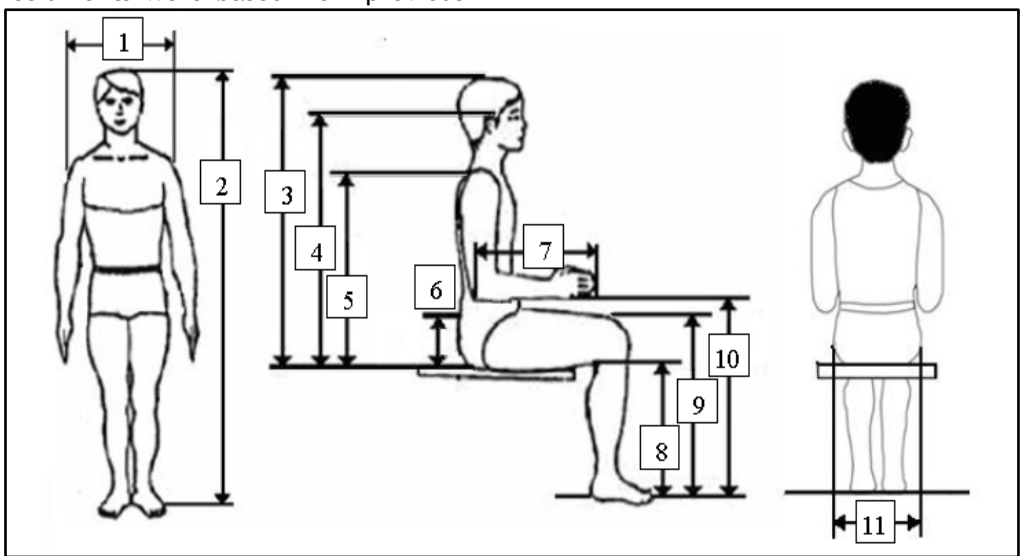

Figure 2 - Student's anthropometric measurement[24]

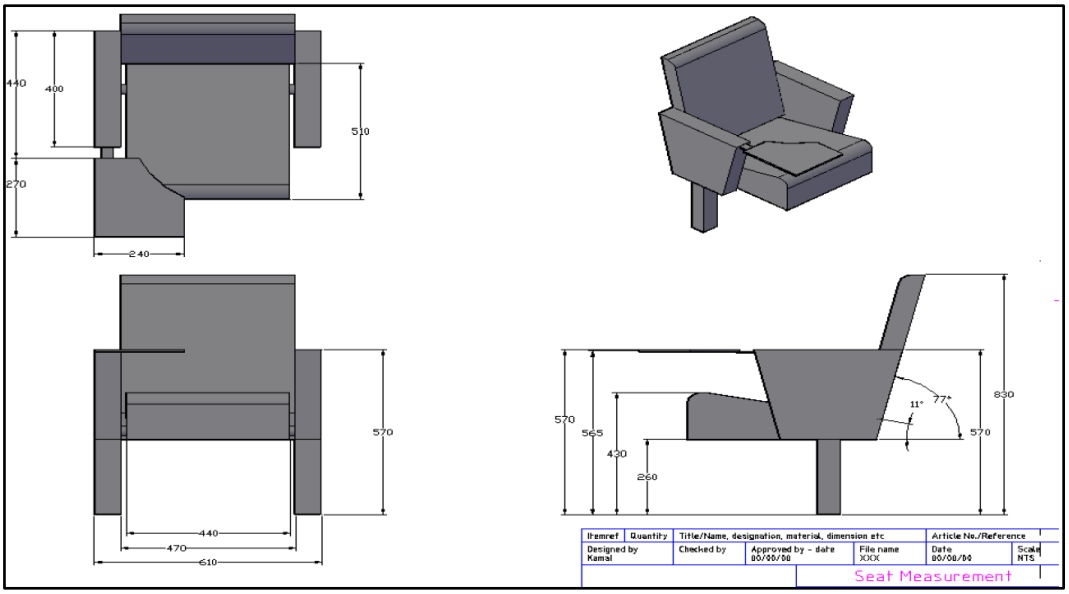

Figure 3 - Seat measurement

To identify the comfort level of seats, a survey questionnaire form adapted from Standard Nordic Questions (SNQ) was used. It consist of a picture of 12 body parts for subjects to choose from in understanding their level of comfort. The comfort level was determined by using five levels of Likert Scale. The most comfort starts with number 1 and decreases to number 5, which possesses the most critical comfort level.

The student's comfort level data analysis was performed using MS Excel and MINITAB-14. The obtained result identifies the average and frequency of the comfort level of the LT seats according to the subject's choice. The incompatibility between body and seat measurement analysis was done through Minitab and SPSS. The result obtained from these software identifies the maximum, minimal, average, standard deviation, error and median of the measurement of the student's body parts. Besides, the percentile of 5%, 50% and 95% to identify the suitable measurement of the student's chair was obtained through these software.

RESULTS

For comfort level investigation, 111 students was involved where 96 (87%) of them are male students. Twelve body parts were measured; eye, neck, shoulder, elbow, upper back, lower back, arm, hand, thigh, knee, ankle and leg, to understand the level of comfort while using the LT seats. The age range of subjects were 19 to 34 years old. Meanwhile, anthropometric data was obtained from 110 male students due to unavailability of female students due to various reasons. The data was analysed using Microsoft Excel and MINITAB-14 software. The comfort level of the students was measured using Likert Scale from 1 to 5 and categorized as follows: T1 = Very comfortable, T2 = Comfortable, T3 = Less comfortable, T4 = Uncomfortable, T5 = Very uncomfortable. The findings of the comfort level are demonstrate in Table 1. The result revolves around level 3 which is less comfortable. Based on this data analysis, it is a clear indication of how the students feels about the comfort of the chairs in the LTs.

Table 1- Comfort level analysis result

Variable	Average	Std. Dev.	Variance
Eye	2.919	1.113	1.239
Neck	3.342	0.968	0.936
Shoulder	3.045	0.976	0.936
Upper back	3.054	1.052	1.106
Elbow	3.018	1.136	1.291
Lower back	3.027	0.977	0.954
Arm	2.982	1.009	1.018
Hand	2.919	1.010	1.021
Tight	3.090	1.075	1.155
Knee	3.324	1.080	1.167
Calf	3.297	1.067	1.138
Feet	3.288	1.082	1.171

The mean distribution of the comfort level for all body parts are shown in Figure 4. The findings shows that the high mean comfort level chosen by the subjects, from highest to lowest order are; neck (3.34), knee (3.32), calf (3.29), foot (3.27), thigh (3.09), upper back (3.05), shoulder (3.05), lower back (3.02) and elbow (3.01). Meanwhile, the body parts that is lower than 3 are; arm (2.96), hand (2.93) and eye (2.92). However, the average comfort level brings the value to 3 (less comfortable). Early conclusion can be made that the seats provided are a mismatch with the student's anthropometry. This incompatibility leads to discomfort to the body parts.

Figure 5 shows frequency of the chosen comfort level according to the body part. Most of the subjects felt less comfortable (T3) on all parts except for foot, arm and elbow. On the foot, most subjects chose T4 (uncomfortable). Most subjects chose T2 (comfortable) for elbow.

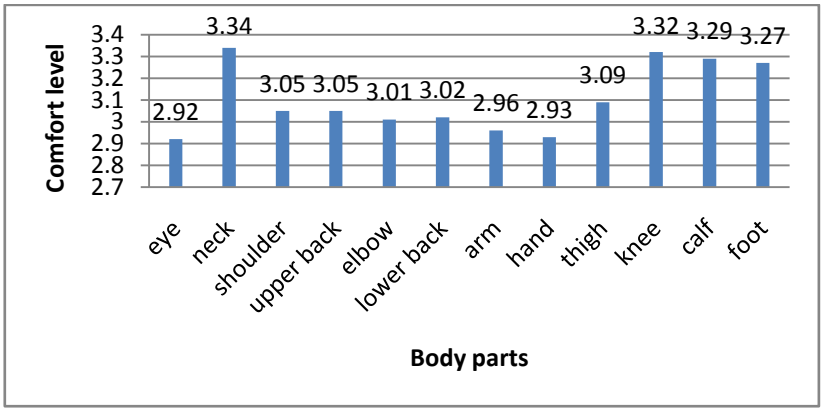

Figure 4 - Comfort level against body part

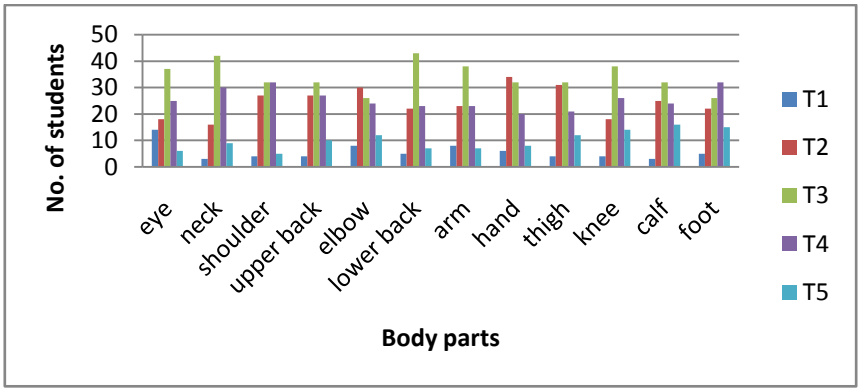

Figure 5 - Frequency of the comfort level according to the body part

Table 2 shows the frequency average of the subjects choosing the comfort level on each body part.

Table 2 - Comfort level frequency percentage

Variables	Level (%)				
	1	2	3	4	5
Eye	14	18	37	25	6
Neck	3	16	42	30	9
Shoulder	4	27	32	32	5
Upper back	4	27	32	27	10
Elbow	8	30	26	24	12
Lower back	5	22	43	23	7
Arm	8	23	38	23	7
Hand	6	34	32	20	8
Thigh	4	31	32	21	12
Knee	4	18	38	26	14
Calf	3	25	32	24	16
Feet	5	22	26	32	15

Eleven body parts were chosen for the anthropometry measurement; shoulder width, height, seating height, eye level while sitting, shoulder height while seating, thigh height, extension length, hind knee height, knee height while sitting, elbow height while sitting and buttock width. The percentile of these data was obtained, as shown in Table 3.

Based on the Table 3, it was found that the ideal seating surface for the students is 411.00 mm which is the 95% acceptance of the students based on hind knee height measurement. The ideal width of seats is 401.15 mm (95%). There were 6 measurements obtained in order to do a comparison with the anthropometric data, as depicted in Table 4.

Table 3 - Subject's anthropometric measurement percentile (mm)

Variables	Percentile	
	5%	95%
1. Chest width	416.10	504.70
2. Standing height	1622.15	1774.5
3. Sitting height	812.75	903.15
4.Eye level height	697.75	795.00
5. Shoulder height	538.65	635.70
6. Hip height	147.75	215.00
7. Arm length	437.55	495.00
8. Hind knee height	411.00	478.90
9. Knee height	512.95	597.80
10. Arm height	569.05	691.90
11. Buttock width	300.55	401.15

Table 4 - LTs seating measurement

No.	Measurement type	Value (mm)
1	Seat height	430
2	Seat width	440
3	Seat inclination	11°
4	Table height	570
5	Table clearance	565
6	Table inclination	0°

The comparison was made to obtain the value and percentage of incompatibility of both measurements. The comparison was done using several matches:

- Seat height and hind knee height
- Seat width and buttock width
- Table clearance and knee height
- Table height and elbow height while sitting

The result of anthropometric incompatibility is showed in Table 5.

Table 5 - Anthropometric and seat measurement comparison result

No.	Comparison between subject anthropometry and seat measurement	Incompatible Total (%)	Compatible Total (%)
1	Seat height and hind knee height	96	4
2	Seat width and buttock width	79	21
3	Table clearance and knee height	52	48
4	Table height and elbow height	79	21

The following figures (from Figure 5 to Figure 8) indicates the incompatibility area using upper control limit (UCL) and lower control limit (LCL).

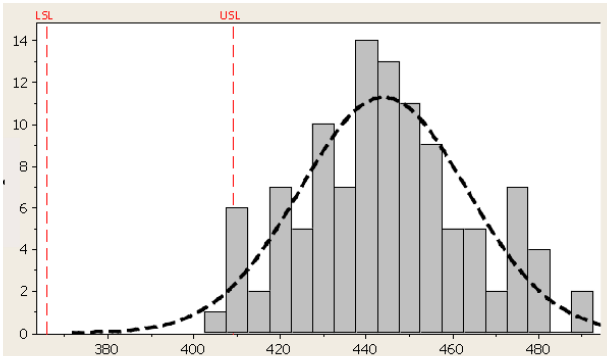

Figure 6 - Seat height and hind knee height comparison in mm (frequency vs. hind knee height)

Figure 6 clearly indicates incompatibility in between hind knee height measurement and seat height. This shows that the seats provided are too low compared to the height of knee of the subjects. This situation leads to subjects were required to bend their legs in order to use the seats.

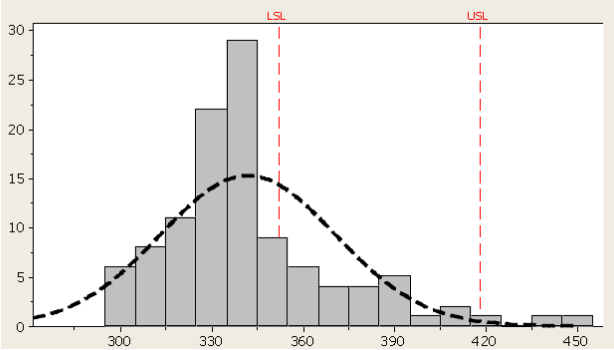

Figure 7 - Seat width and buttock width comparison in mm (frequency versus buttock width)

Figure 7 shows the buttock width measurement and seat width comparison where most subjects are outside the maximum and minimum measurement limit. This causes subjects to feel discomfort on their buttock when using the provided seats.

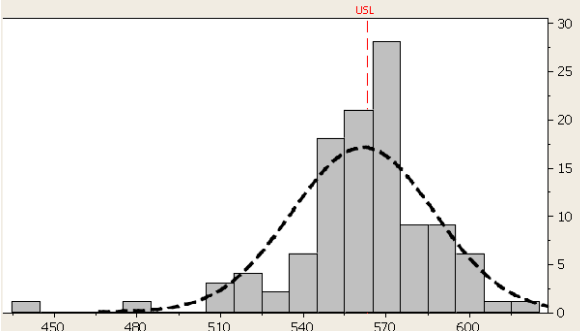

Figure 8 - Table clearance and knee height comparison in mm (frequency versus knee height)

Figure 8 shows that 57% of the subjects exceeds the maximum table clearance compared to their knee height while sitting. This causes their knees are in contact with the bottom of the table surface which leads to discomfort.

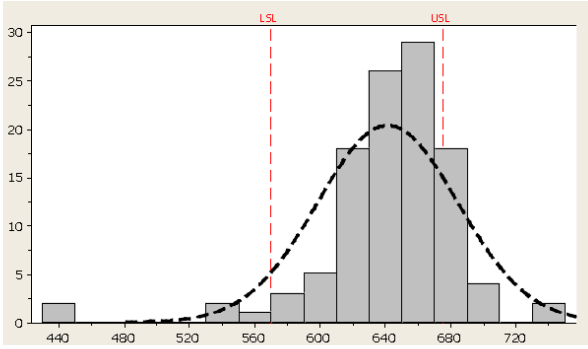

Figure 9 - Table height vs. elbow height in mm (frequency versus elbow height)

Most subjects possess compatible height with the table provided. However, Figure 9 showed there are few subjects having their elbow level below the minimum level and above the maximum level. Based on findings majority of the subjects chose level 3 on most body parts. The legs are the body part that they felt most uncomfortable with. More than 30% felt less comfortable (T3) and more than 22% subjects are in T4 (uncomfortable) while using the seats in LTs. At least 8% felt they are in level 5 (very uncomfortable). With 60% of the students felt uncomfortable, this means only a mere 40% were able to concentrate on their studies while in the LTs.

Based on the comparison of subject's anthropometric measurement and seat measurement proves that the seats in the researched LTs does not fulfil the requirement of the respondent's anthropometry. Only 48% of the subjects are compatible with the four seating measurements.Changes has to be done to overcome the incompatibility issue. Based on the 5^{th} and 95^{th} percentile obtained, the suitable seat measurement can be recommended as shown in Table 6. There are a few measurements that was maintained since it is still relevant such as seat width, seat slope and table slope.

Table 6- Difference between original and suggested measurements

No.	Measurement type	Original measurement (mm)	Suggested measurement (mm)
1	Seat height	430	411
2	Seat width	440	440
3	Seat inclination	11°	11°
4	Table height	570	602
5	Table clearance	565	597
6	Table inclination	0°	0°

CONCLUSION

Thefocus of this study is purely to solve the issues forwarded by the students verbally and based on researcher's observation on the comfort level of the seats in LTs as well as the incompatibility in between students and the seats. This research fulfils two main objectives. It was clear that the seats in the LTs are uncomfortable to be used. The survey questionnaire indicates their discomfort on most body parts while sitting on the seats. Majority of the subjects are incompatible with the seat's measurements. Anthropometric measurement of the subjects are outside the compatibility level of the seats. All four measurements that was matched indicates only less than 40% out of 110 students able to use the seats with comfort. The involved student's data was gathered in this research, which involves 111 students and 11 anthropometric measurements were taken. Seven measurements were done on the seats for compatibility analysis. The analysis result shows that most students are incompatible with the seats. The highest percentage of compatibility is 48%. All hypothesis was solved where there are students who felt uncomfortable using the seats in LTs based on the first objective. The significant difference in discomfort in between the body parts were also identified and it was found out that there are several body parts that is not suitable with the measurements of the seats, in reference to the obtained research objectives.

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