Guidelines for designing class room furniture

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■**ABSTRACT :** The task performance gets influenced to a great extent by the design and dimensions of the physical facilities provided at workplace. A total sample of 10 colleges was randomly selected for this study. Two class rooms from each college, making a total of 20 class rooms were selected for taking the measurements of existing furniture and 320 users were selected for recording anthropometric measurements, based on which guidelines were formulated for designing class room furniture. The results revealed that desk/ table height of the existing furniture was 77.30±4.67 cm as against the formulated dimension of 76 cm and seat height was 43.25±1.65 cm as against the formulated dimension of 44.00 cm. The height of the backrest was 41.20±5.75 cm as against the formulated dimension of 54.80±3 cm and the slope of backrest was 104.30±1.34 degree, whereas it should be 103.00 degree according to the formulation. The differences between existing and formulated dimensions were statistically significant.

■**KEY WORDS :** Class room furniture, Anthropometric measurements, Formulated dimensions

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Class room is a place where students spend most of their time. As they have to spend a considerable amount of time on studies, provision for good study facilities becomes essential. Further, they are not privileged with the variety of furniture which might be available at home. Under such conditions, if the workplace does not permit the students to possess comfortable study table and chair, constant use of the same may cause physiological problems. Comfortable work design would enable them to maintain good body posture and cause lesser physical fatigue. Study table and chair that get into the psycho-physiological requirements of the users contribute towards synchronizing comfort and efficiency.

The major function of the class room furniture is to support the student when writing or drawing on the working surface. The ideal seat is the one in which the person looses all awareness of his seat and posture. In this state, a person is able to give his undivided attention to whatever activities he may wish to pursue. Besides, desk dimension especially the height of desk, play an important role in allowing the worker to maintain comfortable posture. In order to achieve this, it is generally accepted that class room furniture needs to be designed to allow the students to move about in their seats as localized muscle fatigue and pain can result from postural immobilization. One should consider appropriate anthropometrical requirements for seat, work surface, legroom and clearances for getting in and out (Chakrabarti, 2004).

During the past decade, research in ergonomics has led to an improvement in the technology of work and furniture design based on the bio-mechanics of human body. However, the largest workplace of all, *i.e.*, the class room is still being ignored. Studies that provide empirical evidence on the extent and the nature of a possible mismatch between class room furniture and students' bodily dimensions are rare; neither any study has suggested any specification ideally suiting Indian female students and no research has been conducted to meet the anthropometric and design requirements, even though girls' colleges are increasing in number in India now. At present, there are 1800 girls'colleges in India (Chronicle Year Book, 2009). Designing for girls is also significant because they have special requirements. Besides, the stature and anthropometric measurements of female students are entirely different from those of the male students. Thus, there is a need to focus attention on class room furniture designing for girls. Therefore, the present study was designed with the following objectives:

–To formulate guidelines for designing class room furniture for female students based on anthropometric measurements and to compare the formulated guidelines with

the existing furniture.

RESEARCH METHODS

Location of work :

The study was conducted in Ludhiana city. The local selection of sample was purposive because of the easy accessibility and workability for the kind of measurements required.

Selection of the sample :

A total sample of 10 colleges was randomly selected for this study. Two class rooms from each college, making a total of 20 class rooms were selected for taking the measurements of existing furniture. In addition, 16 users from each class room were taken making a total of 320 users whose anthropometric measurements were recorded for formulating the guidelines.

Construction of record sheets :

Two types of record sheets were prepared for the field survey which are explained in detail as follows:

Record sheet for class room survey :

For recording furniture measurements, a record sheet was constructed which recorded various measurements of class room furniture. It included three parts:

Study table/desk dimensions: Height, width, depth and slope.

Study chair dimensions: Height, width, depth, slope, height of backrest, slope of backrest and thigh clearance.

Record sheet for anthropometric measurements :

A separate record sheet was constructed for recording various anthropometric measurements of female students which were further used to formulate guidelines for designing class room furniture.

Data analysis :

The data were analyzed using various statistical tools like averages, frequencies, percentages, percentiles and standard deviation. Further guidelines were formulated for designing class room furniture based on percentile and mean values of various anthropometric measurements. These guidelines were compared with existing furniture dimensions by applying "t" test.

RESEARCH FINDINGS AND DISCUSSION

The experimental findings obtained from the present study have been discussed in following heads:

Formulation of guidelines (dimensions) for designing class room furniture :

The guidelines were formulated for designing class room

Furniture	Dimension	Anthropometric measurement used		Formula used	Formulated dimension	Source
		Anthropometric measurement	Value (cm)			
Study table/desk	Height	Maximum knee height, maximum thigh height	51,19	Maximum knee height+ maximum thigh height+6 cm	76 cm	Roberts (1960)
Study desk	Width	Stature height (H)	155.67	0.40H	62.27 cm	Mathur (1990)
Study table/desk	Depth	Stature height (H)	155.67	0.39H	60.71 cm	Mathur (1990)
Study table/desk	Slope	-	-	-	12.50 degrees	Mandal (1981)
Study chair	Seat height	Minimum sitting popliteal height	44	Minimum sitting popliteal height	44 cm	Roberts (1960)
Study chair	Seat width	Maximum sitting hip breadth	37.59	Maximum sitting hip breadth + 7.5 cm	45.09 cm	Roberts (1960)
Study chair	Seat depth	Minimum sitting buttock- popliteal length	32.50	Minimum sitting buttock- popliteal length+7.5cm	40 cm	Roberts (1960)
Seat slope	35±1.81 degrees	-	-	-	4 degrees	Grandjean (1958)
Study chair	Backrest height	Average sitting shoulder height	54.80	Average sitting shoulder height±3cm	51.80-57.80 cm	Roberts (1960)
Study chair	Backrest slope	-	-	-	103 degrees	Grandjean (1988)
Study chair	Thigh clearance	-	-	-	26.50 cm	Roberts (1960)

Table 1: Formulated guidelines based on anthropometric measurements for designing class room furniture

furniture. These guidelines were formulated based on the anthropometric measurements of the 320 female subjects using class room furniture with allowances for movement and usage. These have been presented in the form of Table 1.
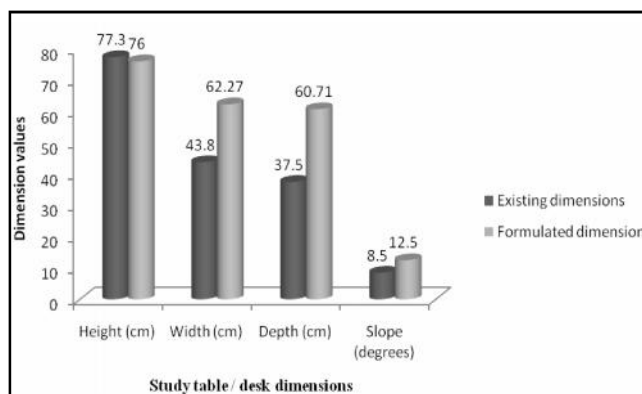
Comparison of existing class room furniture dimensions with formulated dimensions :

The existing furniture dimensions were compared with the formulated dimensions in order to know the gap between the two. This was done to study the drawbacks in the existing class room furniture which was ill fitted and not in accordance with the anthropometric measurements of female students while the guidelines were formulated taking into consideration the anthropometric measurements of female class room furniture users. The Table 2 presents the comparison of existing class room furniture dimensions with the formulated dimensions. The perusal of Table 2 reveals the following comparisons of the existing furniture dimensions with the formulated dimensions.

Study table/desk :

It is evident from Table 2 and Fig.1 that study table/desk height of the existing furniture was 77.30±4.67 cm whereas according to the formulated dimensions, it should be 76 cm. The difference was 1.45±0.05 cm which was found to be statistically significant. This shows a mismatch in the height of the desk and the anthropometric measurements. Excess table height could lead to forward stretching of the body which can create neck and back problems. The width of the desk on the other hand, was 43.80±8.62 cm as compared to the formulated dimension of 62.27 cm. The difference was 18.78±0.55 cm and the t value was found to be statistically significant. This reveals that the space available for writing and drawing work for the students in the existing furniture

was less. A greater space should be provided for this purpose by designing the class room furniture according to the anthropometric measurements. The depth of the table was 37.50±13.08 cm in case of the existing furniture while it should be 60.71cm in accordance with the anthropometric measurements as formulated. The difference between the two was 23.30±1.50 cm which was found to be statistically significant. This indicates that the space provided as depth of the table was inadequate for the female students. This may lead to compressing of arms and can put pressure on the shoulder joints. The slope of the table top in the existing furniture was 8.50±2.62 degree but according to the formulated dimensions it should be 12.50 degree. The gap in this case was 4.25±0.08 degree which was again statistically significant. This angle of slope is particularly required for the drawing work. Lower slopes may lead to acquire forward bending and stooping posture for longer period of time which can cause back problems.

Fig. 1: Comparison of existing study table/desk dimensions with formulated dimensions

Table 2: Comparison of existing class room furniture dimensions with formulated dimensions				
Furniture	Existing dimensions	Formulated dimensions	Gap	t-value
Study table/desk				
Height	77.30±4.76 cm	76.00 cm	1.45±0.05	7.51*
Width	43.80±8.62 cm	62.27 cm	18.78±0.55	5.90*
Depth	37.50±13.08 cm	60.71cm	23.30±1.50	17.38*
Slope	8.50±2.62 degrees	12.50 degrees	4.25±0.08	13.90*
Study chair				
Seat height	43.25±1.65cm	44.00 cm	0.80±0.01	5.20*
Seat depth	43.80±1.66 cm	40.00 cm	3.75±0.04	8.23*
Seat width	42.40±2.19 cm	45.09 cm	2.65±0.03	11.60*
Seat slope	4.35±1.81degrees	4.00 degrees	0.40±0.01	1.73*
Height of backrest	41.20±5.75cm	54.80±3cm	13.70±0.20	6.08*
Slope of backrest	104.30±1.34degrees	103.00degrees	1.35±0.02	7.51*
Thigh clearance height	31.50±2.62 cm	26.50 cm	5.25±0.06	17.30*

*Indicate significance of value at P=0.05

Study chair :

Table 2 further depicts the dimensions of existing chair in comparison to formulated dimensions. The seat height in the existing class room furniture was 43.25±1.65cm while the formulated dimension for this was 44.00 cm. The gap between them was less *i.e.* 0.80±0.01 cm but was statistically significant. This again indicates a mismatch between the two. In case of seat depth, the existing dimension was 43.80±1.66 cm, whereas the formulated dimension for this was 40.00 cm. Here the gap was 3.75±0.04 cm which was also found to be statistically significant. This shows that the existing dimension was more as compared to that expected according to the formulation. The greater depth of the existing seat can lead to forward bending away from the backrest so the user cannot rest her body against it and if she rests the body against it, this would cause stress and discomfort in the backbone. Width of the seat in the existing class room furniture was found to be 42.40±2.19 cm but it was formulated to be 45.09 cm according to the anthropometric measurements of female users. The gap between the two was 2.65±0.03 cm which was also statistically significant. Thus, it can be concluded that the existing dimension was a bit smaller than the formulated one. The smaller seat width would give inadequate space for the hips to rest, thereby causing discomfort in the lower back and thigh. Seat slope present in the existing class room furniture was 4.35±1.81 degree but according to the guidelines there should be 4.00 degree slope in the seat. The difference was 0.40±0.01 degree which was statistically significant. Thus, it can be observed that the seat slope was almost appropriate according to the dimension.

It is again evident from Fig. 2 that the height of the backrest in the present class room furniture was 41.20±5.75 cm but if it was compared with the formulated dimension, it was considerably smaller than the required measurement of 54.80±3cm.The gap was 13.7±0.20 cm which was statistically
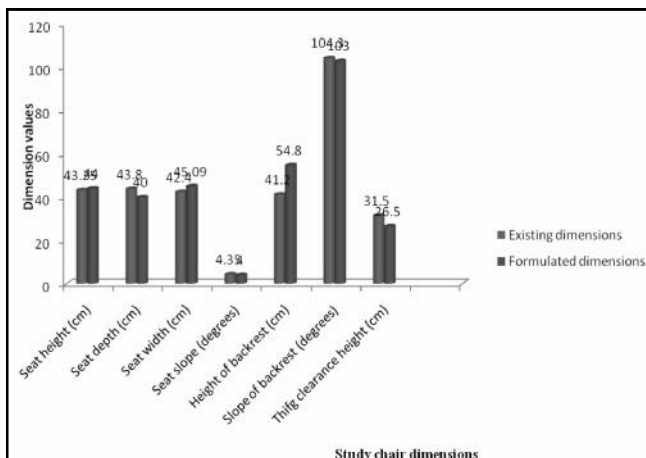
significant. The smaller height of the backrest would not provide enough support to the back, thereby casing stiffness and discomfort in the upper back, spine and even neck. It can be further observed that the slope of the existing furniture was 104.30±1.34 degrees, whereas it should be 103.00 degrees according to the formulated dimension. Here the gap was1.35±0.02 degrees which was statistically significant. It is again evident from the Table 2 that the height of seat in relation to work surface was 31.50±2.62 cm in case of existing furniture. But this dimension should be 26.50 cm as formulated. The difference was 5.25±0.06 cm which was significant statistically.

Conclusion :

The results of present study revealed a considerable mismatch between existing furniture dimensions and those based on anthropometric measurements of female students. A mismatch that is statistically significant was observed in all the dimensions. This mismatched or ill fitted furniture can lead to problems like, fatigue, muscular stress and pain/ discomfort in different body parts and the free movement of students in the class room can be obstructed. This in turn results in greater fatigue and discomfort and is likely to lead to poor postural habits as well as neck or back complaints. Most importantly, musculo-skeletal stress resulting from efforts to maintain stability and comfort of seating may make for a fidgety individual, a condition not conducive to focused learning.

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Fig. 2: Comparison of existing study chair dimensions with formulated dimensions

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