



Ergonomic Assessment of Classroom Furnitures in K.S.Rangasamy college of Technology

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Abstract: Ergonomics is about 'fit': the fit between people, the things they do, the objects they use and the environments they work in. Sitting at classes on a comfortable seat advances the comfort, health, well-being and safety of the person who uses the chair. The poor ergonomic classroom furniture is frequently considered one of the major causes of severe posture problems in adulthood .The most engineering class room activities involve sitting for long period of time, with little or no breaks .The poorly designed furniture fails to take account of anthropometric measurements & characteristics of its user has a negative influence of the human health. The purpose of study was to examine the anthropometric match of the classroom furniture with standard ones. The dimensions of the table and desks are available by measuring in class room. The writing desk was made up by composite wood which is covered by thin layer of mica sheet. The sitting and lying table were made up of massive wood. The structural defect of the furniture like cracks, scratches and breaks were also taken into account.

Keywords: anthropometry, ergonomics, furniture measurements.

1. Introduction

Ergonomics is a science concerned with "fit" between people and their work. It puts people first, taking amount of their capabilities and limitations. Ergonomics is the design of workplace & work environment has gained attention from researchers over the last few decades. Though classroom environment represents the "work" environment for billions of students, it has not attracted the proper attention from ergonomists proper implementation of classroom.

Ergonomics is needed for the maintenance of good health, improvement in

academic performance, learning and motivation. The most important element of the classroom environment is the furniture. The major function of classroom furniture is to support the students when writing or drawing on the working surface. Besides, a classroom has to facilitate learning to increase the work efficiency of the students by providing a comfortable and stress free working environment suitable for intellectual activities.

Colleges are the places from where we get qualified graduates which then help in building the nations. Therefore, it is very

important to make the classroom in colleges comfortable and suitable for students so that as they can concentrate and evolve as talented Individual. Students spend a major time on the chair and desk, during college hours. Hence it is necessary that the college furniture should fit the environments of the students. Therefore, the college furniture should be made on the basis of anthropometric dimension of the users. It should permit space for flexible movements of the body and provide place for all the educational activities. Although all the components of classroom furniture are important, yet furniture for seating requires special attention as it facilitates the functioning of the students in a classroom. Hence, the design of work chair and table requires anthropometric data which are appropriate to the population of users for when the Plan is intended.

Anthropometric data is a collection of the dimensions of the human body and are useful for ergonomic design of the workplace. It has been noted that anthropometric data vary considerably for individuals. The use of anthropometry in design may improve the well being, health, comfort and safety of the user of the product. The use of anthropometric data in the design of classroom bench and tables in almost all developed countries has been acknowledged. One of the conditions to support productivity is to ensure that the workplace and the furniture that student use confirm the anthropometric characteristics of the user. Appropriate anthropometric requirements should also be considered for seating, for seat and work surface dimensions, legroom and clearances for getting in & out (Chakrabarti, 1997).

The discomforts of muscle contracture of neck and back problems are due to sitting for a long time at inappropriate posture, resulting from using furniture that is not consistent with anthropometric characteristics of the users.

1.1 Objectives

- To collect the relevant anthropometric data of post graduate male students using classroom furniture.
- To determine the ergonomic suitability of classroom furniture and their user friendly attributes.
- To explore the opinion of students about fitness of furniture.
- To give recommendation and guideline of designing of suitable classroom furniture.

1.2 Limitation

- The study is limited only to K.S.Rangasamy College of Technology and Technology
- The study is limited to post graduated male students only

1.3 Scope for Further Research

- Ergonomic design of classroom furniture for physically challenged
- Conducting similar study in other institutions
- Ergonomic design of computer work station

2. Literature Review

A review of literature is an essential part of a research which is a careful examination of the literature pointing towards the answer to the research question.

Qutubuddin *et al* (2013) noted that incompatible furniture forced the students to adopt unnatural postures (lateral bend, forward bend, twisting etc) in the classroom for long period which imposes physical and mental strain on the students. Fatigue may also be caused by sitting for long duration of time in the classroom adopting to improper

posture and may lead to operational uneasiness and musculoskeletal and some physiological disorders among children.

Saleh *et al* (2013), the student posture analysis revealed that the new seats had better and comfortable angles when compared to the current sets in terms of neck, back and eye angles. In addition, subjective opinions showed that students were more comfortable using the new sets when compared to the current ones.

Ismail *et al* (2017), on his work on *anthropometric measurements for ergonomic design of students furniture in india*, recommends highly recommended to consider requirements from students in designing classrooms furniture and conduct seminar or workshop to educate students regarding the negative impact towards adapting poor posture in the long usage of classrooms furniture.

Ahamed *et al* (2015), on his research on *anthropometric evaluation of the design of the classroom desk for the fourth and fifth grades of Benghazi primary schools*, finds there is considerable percentage of mismatch between the desk dimensions and students anthropometry. So, equation relating body dimensions to desk dimensions must be utilized for recommendation of new design of furniture.

Lucio Canete *et al* (2015), on his work *Relationship between the ergonomic state of the classroom measured in energy units and the well-being of students observed by non-invasive instrumentation*, they aimed to measure the ergonomic level of a classroom by means of the quantification of two readily measurable variables. They observed there is clear correlation between energy and movements, confirming that both variables are quantitative indicators of the ergonomic state of the classroom, the main artificial ecosystem of learning.

Adila Md Hasim *et al* (2012), in his work *Kano Model and QFD integration approach for*

Ergonomic Design Improvement, they presented two methods of Kano Model and Quality Function Deployment to improve the school workshop's workstation design for adolescent in terms of ergonomic and users need. At the end, they were able to prioritize the modification elements to be implemented into the new ergonomically designed workstation.

Danille M. Ivory (2011), in his study on *the impact of dynamic furniture on classroom performance*, his study revealed that no one type of furniture provides the same effect for all elementary students, but rather than personal characteristics may dictate the best match for focus, work completion, and neatness.

Hasan Kurban *et al* (2015) in his study on *Ergonomics and structural analysis of classroom furniture, a case study for high schools in bartin, Turkey*, his study recommended that studies should be focused on collecting more anthropometric data and share this information for furniture manufacturers for ergonomically designed desks.

Dianat (2013) and Mohammed Thariq (2010), *Anthropometric measurements for the design of furniture ergonomically In designing classroom furniture*, from this study, their following anthropometry measurements have been considered. Unless otherwise stated it is assumed that the participants sit fully erect with thighs fully supported and the person is freely supporting the feet flat on the floor.

The various anthropometric measurements suggested by them are given below

- Popliteal height
- Sitting eye height
- Sitting height
- Sitting elbow height
- Thigh clearance
- Knee height
- Buttock knee length

- Elbow to elbow breadth
- Hip breadth
- Sitting shoulder height
- Sitting lowest rib-bone weight
- Sitting upper hip bone height
- Fore arm finger tip length
- Buttock popliteal length
- Stature

Ryan et al(2015),in his paper on *development of an ergonomically designed drafting table and chair for engineering students of LPU-LAGUNA based on anthropometric measurement*, they have used NORDIC musculoskeletal form to ascertain the current status of workstation which shows the severely affected anatomical parts, the NORDIC and RULA(Rapid Upper Limb Assessment) were used to evaluate the posture and in development of new adjustable furniture.

Nase Al-Hinai et al(2018) in his research *An ergonomic students chair design and engineering for classroom environment*, they conducted their research to improve the comfort of students in study environment. They, stated an ergonomic chair must ensure and satisfy all basic needs of the students in the classroom environment.

Ernest Boampong et al(2015) in his work on *Ergonomic Functionality of Classroom Furniture in Senior High Schools in Ghana*, the study revealed prevalence rate of neck pain was according to class, age, sex, weight and height experienced by students were high. The study also founded significant association between flexed postures and upper back pain. Static postures neck pain and low back pain were also associated. So furnitures must be evaluated with generation people.

Qutubuddin et al(2013) in his work, *anthropometric consideration for designing students desks in engineering colleges*, it was aimed to reveal the extent of mismatch between different dimensions of students furniture and the respective anthropometric measure of students, but it revealed the

incompatible furniture forced the students to adopt unnatural postures in classroom for long period. It recommends developing anthropometric data base of students for development of furniture.

3. Materials and Methods

This chapter provides a detailed description of the procedure adopted for conducting the research on "A study on Ergonomic Evaluation of Classroom Furniture for Girls students". After reviewing the literature relevant to study and formulating the objectives of the study, the methodology for this study is established.

The details of methodologies adopted to the investigation is stated under the following section

3.1 Research design

3.2 Locale of the study

3.3 Selection of the sampling method

3.4 Selection of sample

3.5 Tools used for the study

3.6 Collection of data

3.7 Equipment used

3.8 Analysis of data & interpretation

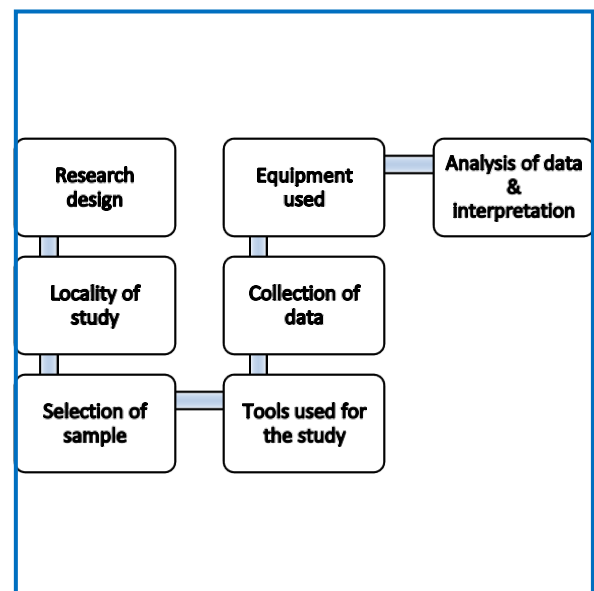


Fig. 1 Methodology flow chart

3.1 Research design

Research design refers overall strategy to choose and integrate the different

component of the study in a coherent and logical way, thereby, ensuring one to effectively address the research problem. It constitutes the blue print for the collection, measurement & analysis of the data. The design followed for the study is an exploratory research. The objective of exploratory research is to gather, preliminary information that will help to define problems & suggest hypothesis. The research design is adopted to determine the ergonomic suitability of classroom furniture for all students.

3.2 Locale of the study

Location of the study area should be appropriate to achieve the objective of research. The study is carried out in K.S.Rangasamy College of Technology purposively from Anna University, to explore the types of classroom furniture user and their suitability with the user population. This college is selected for the reason to study about ergonomic design for classroom furniture because it has not been studied earlier.

3.3 Selection of sampling method

Sampling is a process of selecting a number of participants for a study in such a way that they represent the larger group for which they are selected. A data sample is a set of data collected and selected from a statistical population by a define procedure. Purposive random sampling techniques are adopted for the study to avoid bias. Around 20 numbers of students from K.s.rangasamy College of technology are selected as a sample. Their age range between 21-27.

3.4 Tools used for the study

The tools selected for collecting the data was an Observation of anthropometric survey sheet.

In the 1 st section, general information regarding respondent's age, education institutions are included. In the 2nd section it means specific information regarding anthropometric measures of respondents, dimensions of classroom furniture observed & obtained.

3.5 Collections of data

(A) Anthropometric measures:

Anthropometric measurements are considered as the basis for the design of furniture ergonomically. Hence, different anthropometric measures of the students are taken by adopting proper definition and standard measuring techniques (Chakrabarti, 1997). Accuracy and repeatability of measurement was achieved by practice prior to the data collection. All the subjects were wearing light clothes and were bare footed during measurements. During measuring body dimensions under sitting conditions, the subjects were asked to sit in such a way that the upper leg and lower leg remained at right angle to each other. Height was taken standing erect without shoes. The following human body dimensions, which are essential for seating & work surface design, according to literature survey, were measured in this study. The different anthropometric dimensions measured are stature, sitting height, sitting shoulder height, popliteal height, Hip breadth, Elbow rest height (sitting), Buttock popliteal length, Buttock knee length, Thigh clearance, Sitting eye height, Shoulder breadth, Knee height, forearm hand length, Weight Indian anthropometric Dimensions, National institute of design publishers, Ahmadabad.

(B) Furniture Dimensions

Classroom must be designed to promote a level of comfort & effectiveness, which will promote optimum conditions for study, listening, reading, & interaction. Hence, the dimensions for Desk height, Desk depth, Desk length, Desk slope, Seat height, Bench length,

Back rest height, Bench depth, Back rest slope, foot rest height, distance between chair & bench, thickness of bench etc. are given importance to increase utility & convenience of furniture in classroom. The dimensions of furniture were taken down

3.6 Equipment used

The equipment used for anthropometric measurement & to measure furniture dimensions are height measuring scale, weighing balance, measuring tape and a plastic half circle protector, steel scale. All the measurements were recorded in centimeters except the seat slopes and desk slopes which are measured in degrees.

3.7 Analysis of data and interpretation

Analysis is the critical examination of the assembled & grouped data for studying the characteristics of the object under study. The data thus collected is 30 selected respondents are tabulated & analysed. Descriptive statistics of mean maximum value, minimum value, Standard deviation, percentage, percentile value are used appropriately to summarize the collected data.

4. Experimental Setup and Procedure

Anthropometric survey was done in the present study in order to measure the various anthropometric measurements which were further used to formulate the guidelines to design suitable furniture according to the requirements of the students. Anthropometric data are widely used in determining the dimensions of furniture.

All the anthropometric measurements are taken with the subject in a relaxed and erect posture. Each student is measured in light clothing and without shoes. Student dimensions are taken with student seated erect on a flat horizontal surface (with

exception of height and weight) with knees bent 90 degree and feet (without shoes) flat on horizontal surface. Height is taken standing erect without shoes by height measuring scale. Various human body dimensions, which are essential for seating and work surface design, are measured in this study.

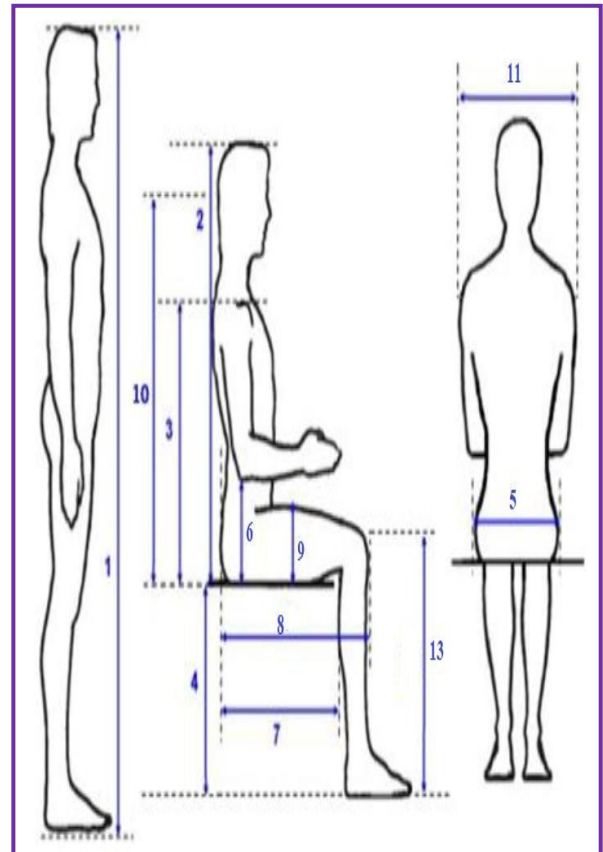


Fig 4.1 Anthropometric picture representational

4.1 Anthropometric Measurements

Anthropometric dimensions are considered as the foundation for designing ergonomically fit classroom furniture. Therefore, anthropometric measurements were taken according to the needs.

1. Stature: Top of the head, standing in erect stretched posture. The vertical distance from the floor to the vertex (i.e. the crown of the head)
2. Sitting height: Top of the head sitting in a normal relaxed posture.

3. Sitting mid shoulder height: Height of upper most point on the middle level of the shoulder.
4. Popliteal height: Height of the underside of the thigh immediately behind the knee.
5. Hip breadth: Maximum horizontal distance across the hips.
6. Elbow rest height: Distance between seat and lower most part of the elbow
7. Buttock popliteal length: Horizontal distance from the most posterior point on the uncompressed buttocks to the back of the lower leg at the knee
8. Buttock knee length: Horizontal distance from the most posterior point on the uncompressed buttocks to most anterior point on the knee
9. Thigh clearance: The vertical distance from the seat surface to the maximum bulge on the anterior surface of the thigh was measured with a shortened anthropometry.
10. Sitting eye height: Height of inner corner of the eye sitting in normal relaxed posture.
11. Shoulder breadth: Maximum horizontal distance across the shoulders,
12. Forearm hand length: Maximum distance between elbows to the middle finger in hand.
13. Knee height: Height of uppermost point on the knee.
14. Weight: Total body mass of the body.

4.2 Furniture Measurements

The most common type of classroom furniture model used in our college is in Fig 4.5. These furniture items are made by nearby furniture manufacturers with the absence of

Standard ergonomic measurements. To identify the potential mismatches, the following measurements of the existin classroom furniture are considered.

Seat Height (SH). Seat height is measured as the perpendicular distance from the floor to the middle point of the front edge of the seat.

Seat Width (SW). Seat width is measured as the horizontal distance between the lateral edges of the seat.

Seat Depth (SD). This is the minimum distance measured horizontally from the front edge of the sitting surface to its back edge.

Seat to Desk Height (SDH). This is the vertical distance from the top of the front edge of the seat to the top of the front edge of the desk.

Seat to Desk Clearance (SDC). This is the vertical distance from the top of the front edge of the seat to the lowest point below the desk.

Desk Width (DW). Desk width is measured as the horizontal distance between the lateral edges of the desk.

Desk Height (DH). Desk depth is the distance from the back to the front of the top surface of the desk.



Fig 4.2 Measuring Back Rest Height

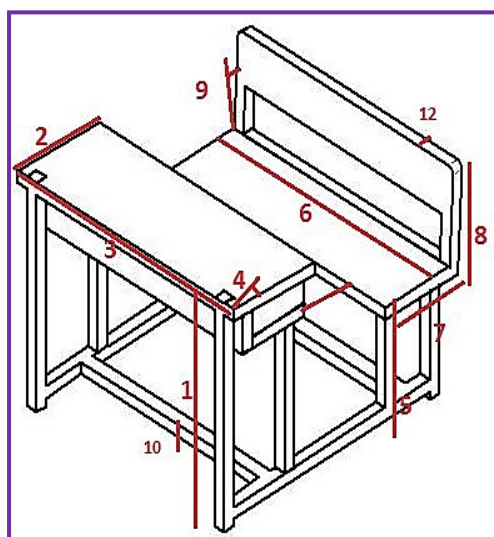
Back Rest Height (BRH): Measured from the bottom of the backrest post to the top of the backrest canvas. Backrest height depends on the degree of disability and level of support required.



Fig 4.3 Measuring Desk Height (DH)



Fig 4.4 measuring Seat Width (SW)



1. Desk Height 2.Desk Depth 3.Desk Length

- 4. Desk Slope 5.Bench Height 6.BenchLength
- 7. Bench Depth 8.Backrest Height 9.Backrest Slope
- 10. Footrest Height 11.Distance b/w Desk and Bench

Fig 4.5 existing class room bench model

The finding from the measurement of the student body dimensions and the classroom desks used are that a considerable mismatch occurs between the furniture and the users. A mismatch can be defined as incompatibility between the dimensions of the student’s body and the

Table 4.1 dimensions of the desks in classroom

| S.no | Furniture part | Readings |
|------|---------------------------------|----------|
| 1 | Desk height | 84 |
| 2 | Desk depth | 42.5 |
| 3 | Desk length | 109 |
| 4 | Desk slope | - |
| 5 | Bench height | 51 |
| 6 | Bench length | 106 |
| 7 | Bench depth | 30.5 |
| 8 | Backrest height | 40.5 |
| 9 | Backrest Slope(degrees) | 95 |
| 10 | Footrest Height | 8.5 |
| 11 | Distance Between desk And Bench | 29.5 |
| 12 | Thickness | 1.9 |

4.3 Classroom Furniture and Body Dimensions Mismatch

Mismatch implies as the irregularity between the college furniture dimensions and the student anthropometric measurements. Identification of a match or mismatch is

important for designing and evaluating classroom furniture.

To characterize the range in which every furniture dimension is viewed as fitting, related anthropometric measurement and ergonomic standards can be utilized. Different relations have been established to identify a match or mismatch. The most common relations are described below.

4.3.1 Popliteal Height (PH) against Seat Height (SH)

The seat height (SH) is required to be balanced in respect to the popliteal height (PH) and enabling the knee to be flexed so that the lower legs shape a greatest of 30° edge with respect to the vertical. PH ought to be higher than the SH. The lower leg constitutes a 5–30° point with respect to the vertical and Further more the shin-thigh edge is in the vicinity of 95 and 120°. Typically, PH does not have an esteem higher than 4 cm or 88% of the PH. PH and SH are characterized when the seat stature is either >95% or <88% of the popliteal tallness and it is conceivable to build up a model for SH. For this examination work, 3 cm correction for shoe stature is incorporated to the popliteal tallness. In this way, a match model is built up as indicated by the following condition

$$(PH + 3) \cos 30^\circ \leq SH \leq (PH + 3) \cos 5^\circ.$$

4.3.2. Buttock Popliteal Length (BPL) against Seat Depth (SD)

Seat Depth ought to be no less than 5 cm not as much as the buttock popliteal length. In any case, the thigh would not be upheld enough if the SD is significantly not exactly the BPL of the subjects. Different scientists clarified that the seat depth ought to be measured for the fifth percentile of the BPL appropriation so that the backrest of the seat can bolster the lumbar spine without pressure of the popliteal surface. Along these lines, a

crisscross among SD and BPL is characterized when SD is either <80% or >95% of BPL. In this way, a match model is built up as indicated by the following condition:

$$0.80BPL \leq SD \leq 0.95BPL.$$

4.3.3 Hip Breadth (HB) against Seat Width (SW)

The seat width must be sufficiently extensive to oblige the client with the biggest hip expansiveness to accomplish solidness and allow space for horizontal developments. Different inquiries have demonstrated that the HW ought to be more slender than the SW keeping in mind the end goal of having an appropriate fit in the seat and an ideal seat width is chosen for the 95th percentile of HW conveyance or the biggest HW. The updated proposed condition shows that the SW bought to be no less than 10% (to oblige hip broadness) and no more than 30% (for space economy) bigger than the hip expansiveness. Along these lines, a match rule is controlled by the following condition:

$$1.10HB \leq SW \leq 1.30HB.$$

4.3.4. Sitting Elbow Height (SEH) against Desk Height (DH)

Various reviews demonstrated that the elbow height is measured as the central point for the work area stature. As the load on the spine decreases, the arms are upheld on the desk and the desk height is liable to the shoulder flexion and shoulder snatching edge which is obtained by the fifth percentile. Thus, the work area stature ought to be 3–5 cm higher than the SEH. Subsequently, a match measure is set up with a changed condition that acknowledges the SEH as the most minimal stature of DH and considering that the extraordinary tallness of DHought not to be higher than 5cm over the SEH.

$$SEH \leq DH \leq SEH + 5.$$

4.3.5 Thigh Clearance (TC) against Seat to Desk Clearance (SDC)

The reasonable seat to work area should be more noteworthy than thigh freedom keeping in mind the end goal of making leg development accessible. The minimum perfect seat to desk clearance ought to be 2 cm higher than thigh clearance. In this manner, a match paradigm is perceived by the following condition:

$$TC + 2 < SD$$

5. Results and Discussion

Anthropometric survey was done in the present study in order to measure the various anthropometric measurements which were further used to formulate the guidelines to design suitable furniture according to the requirements of the students. Anthropometric data are widely used in determining the dimensions of furniture. All the anthropometric measurements are taken with the subject in a relaxed and erect posture. Each student is measured in light clothing and without shoes. Student dimensions are taken with student seated erect on a flat horizontal surface (with exception of height and weight) with knees bent 90 degree and feet (without shoes) flat on horizontal surface. Height is taken standing erect without shoes by height measuring scale. Various human body dimensions, which are essential for seating and work surface design, are measured in this study.

5.1 Sitting Height

Mean sitting height recorded for the sample is 71.3 cm for which the percentile values calculated were 71.3 cm (5th percentile), 77.5 cm (50th Percentile) and 83.73 cm (95th percentile). Sitting height is needed to determine the Back rest height of the chair and height of table or desk.

5.2 Popliteal Height:

Mean popliteal height while sitting is observed 39.72 cm for which the percentile value calculated is 35.57 cm (5th percentile), 40 cm (50th Percentile), and 43.86 cm (95th percentile). This measurement is used for determining the height for the sitting surface.

5.3 Sitting Shoulder Height:

Mean sitting shoulder height recorded is 52.6 cm for which the percentile values calculated are 50.2 cm (5th percentile), 52 cm (50th Percentile) and 54.9 cm (95th percentile). This anthropometric measurement is useful for determination of table height for a particular user population.

5.4 Hip Breadth

Mean hip breadth while sitting is 32.39 cm for which the Percentile values calculated were 27.43 cm (5th percentile), 32.5cm (median) and 37.34 cm (95th percentile). This measurement is required to determine the width of the seat.

5.5 Elbow Rest Height (Sitting)

Mean sitting elbow rest height is recorded as 27.63 cm for which the percentile values are calculated are 25.5 cm (5th percentile), 27 cm (median) and 29.75 cm (95th percentile). The anthropometric measurement is Useful for determination of the table height.

5.6 Buttock Popliteal Length

Mean buttock popliteal length while sitting is 40.97cm for which the percentile values recorded are 35.57cm (5th percentile), 40cm (median) and 46.36cm (95th percentile). This measurement is required to determine the seat depth.

5.7 Buttock Knee Length

Mean buttock knee length recorded while sitting is 48.77cm for which the percentile values calculated are 42.86 cm (5th percentile), 48.75cm (50th percentile) and 54.67cm (95th percentile). This measurement is used to determine the depth of the seat.

5.8 Thigh Clearance (Height)

Mean thigh clearance recorded for 20 subjects in sitting position is 13 35cm for which the percentile values calculated are 10.7cm (5th percentile) 13.75cm (50th percentile), 15.99cm (95th percentile), This thigh height from seat is used for determining the vertical span to accommodate thighs between the bench top and underside of the desk.

5.1 Sitting eye height

Mean sitting eye height of the subject was 68.27cm for Which the percentile values calculated are 59.38cm, 68.75cm and 77.15cm for the 5th percentile, 50th percentile and 95th percentile respectively. In this classroom situation this dimension is particularly important for the black board height.

5.10 Shoulder breadth

The mean shoulder breadth is found as 41.09 cm for which the percentile values are calculated as 30.26cm (5th percentile), 35cm (50th percentile), and 41.09cm (95th percentile). This measurement is required for determining the backrest.

5.11 Knee height

Average knee height recorded for the subject while sitting is 48.17cm for which the percentile values are 43.53cm, (5th percentile), 47.5cm (50th percentile), and 52.8 cm (95th percentile) .This anthropometric measurement is Important for designing the vertical distance from the knees to the table top and for Determining the upper age of the sitting surface.

5.12 Fore arm hand length

The maximum length from the underside of elbow to The 3rd metacarpal of hand. The minimum & maximum value is 36cm and 43cm. Average fore arm hand length is 36.53cm. The 5th, 50th and 95th percentile value is 36.4cm, 39.37cm and 42.58cm respective.

| S. NO | CONTENTS | Min Value | Max Value | 5 th percentile | 50 th percentile | 95 th percentile | mean | Standard deviation |
|-------|------------------|-----------|-----------|----------------------------|-----------------------------|-----------------------------|------|--------------------|
| 1. | Stature | 141 | 182 | 147 | 161 | 172 | 160 | 8.78 |
| 2. | Sitting height | 61 | 91 | 67 | 79 | 90 | 79 | 7.12 |
| 3. | Shoulder height | 38 | 73 | 46 | 54 | 67 | 55 | 7.44 |
| 4. | Popliteal height | 30 | 64 | 34 | 40 | 45 | 41 | 3.2 |
| 5. | Hip breadth | 26 | 43 | 30 | 34 | 38 | 34 | 2.76 |

| | | | | | | | | |
|-----|--------------------------|----|------|------|----|------|------|------|
| 6. | Elbow rest height | 13 | 31 | 16 | 20 | 24.5 | 20 | 2.6 |
| 7. | Buttock popliteal length | 21 | 53 | 37 | 44 | 49 | 44 | 3.83 |
| 8. | Buttock knee height | 32 | 65 | 41 | 50 | 64 | 50 | 6.82 |
| 9. | Thigh clearance | 11 | 18 | 11.5 | 15 | 18 | 14.5 | 1.7 |
| 10. | Sitting eye sight | 55 | 80 | 57 | 68 | 79 | 67 | 8.2 |
| 11. | Shoulder breadth | 26 | 52 | 31 | 40 | 48 | 40 | 5.25 |
| 12. | Forearm hand length | 42 | 52.5 | 43 | 47 | 50 | 47 | 3.9 |
| 13. | Knee height | 32 | 95 | 40 | 47 | 54 | 47 | 4.88 |
| 14. | Weight (in kgs) | 58 | 87 | 62 | 72 | 85 | 72.5 | 6.78 |

| Features | Anthropometric Measures | Proposed Design Dimension | Criteria |
|-------------------|--|---------------------------|---|
| Desk/Table Height | Seat height+Elbow height+Shoe heel allowance | 70.3cm | Maximum table height=5 th percentile of seat height+5 th percentile of functional elbow height(sitting)+shoe heel allowance |
| Desk depth | Forearm hand length | 50cm | 95 th percentile of fore arm-hand length |
| Desk length | Hip breadth | 104cm | 95 th percentile of hip breadth+ 15% allowance for clothing+ 15% allowance as clearance(5.601 is taken as clearance |
| Desk slope | | 15 degree | |
| Bench/seat height | Popliteal height | 36cm | 5 th percentile of popliteal height+2cm shoe heel allowance |
| Bench length | Hip breadth sitting | 39.9cm | 95 th percentile of hip breadth sitting+ 15% allowance for clothing |
| Bench depth | Buttock popliteal length | 49cm | 95 th percentile of buttock popliteal length |
| Back rest slope | | 110 degree | Enhances support to lumbar region |
| Back rest height | Sitting shoulder height | 46cm | 5 th percentile of sitting shoulder height |

6. Conclusion

Classroom is a place where students spent most of their time. They remain seated in the classroom for a considerable amount of time. Prolong static posture puts on extreme physical strain on muscles, the ligaments and in particular on the discs. Correct sitting posture is an important factor for the prevention of their disorder as well as enhances the efficiency of the students by encouraging and motivating them to perform better. Recent researchers have documented an increase health problem related to poor sitting posture. Neck,

Shoulder and back pain problems are common among the college students. Students experience such problem due to low quality design desk bench. Hence, it is necessary that the college

Furniture should fit the requirements of the students. Matching furniture to anthropometric measurements is an important factor that should be taken into account in college furniture design.

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 the human body. However, the largest work place of all, i.e the classroom is still being ignored. Thus there is a need to focus attention on classroom furniture

Considering the importance of ergonomically designed classroom designed furniture for students, the present study is planned with the following objectives.

- To determine the ergonomic suitability of classroom furniture & their user friendly attributes
- To explore the opinion of students about fitness of furniture.
- To give recommendation & guideline of designing suitable classroom furniture

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