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EVALUATING STUDENTS' ANTHROPOMETRIC DATA AND SCHOOL COMPUTER LAB FURNITURE DIMENSIONS FOR A "PERFECT FIT"

Dyuti Panwala* and Roopa Rao**

*** Corresponding Author, Student** ****Guide and Associate Professor**

Department of Community Resource Management. College of Home Science Nirmala Niketan (Affiliated to the University of Mumbai), Mumbai – 400020, Maharashtra

Abstract

An exploratory study was conducted among 160 students aged 6 – 16 years from eight schools in Mumbai and its suburbs. The study aimed to assess the anthropometric fit with computer lab furniture, driven by the need to uncover the consequences of potential misfits between students' anthropometric dimensions and the furniture. Misalignments can lead to musculoskeletal discomfort, inhibiting concentration, and learning outcomes. The study underscored the inadequacy of a "one-size-fits-all" approach to furniture design in educational settings. The methodology involved gathering relevant anthropometric measurements of students and furniture dimensions from school computer labs. Anthropometric data were collected using measures such as measuring tape and anthropometric stools. A self-constructed questionnaire was administered to gather additional data. Data analysis utilized simple statistical techniques to identify correlations and discrepancies. The study revealed the importance of accommodating students with varying anthropometric dimensions to foster a conducive learning environment. Recommendations for changes in furniture design and seating arrangements were proposed based on the evidence generated. Addressing discrepancies could promote student comfort, enhance concentration, and improve learning outcomes. Furthermore, the study served as a proactive measure to safeguard students from physical discomfort and ergonomic challenges associated with improper furniture design. Raising awareness among students about maintaining proper posture and addressing ergonomic concerns was a key aim of the research. This exploratory study highlighted the significance of prioritizing student comfort and well-being in educational settings. By addressing ergonomic discrepancies and implementing appropriate design modifications, schools can create environments that foster optimal learning experiences for all students.

Keywords: Anthropometric measurements, ergonomics, school computer labs, student well-being, musculoskeletal discomfort.

Introduction:

In contemporary educational settings, the integration of ergonomically designed furniture within school premises, especially in computer labs, plays a pivotal role in fostering conducive learning environments. Anthropometrically suited furniture, tailored to the diverse physical dimensions of students, has emerged as a critical aspect of ensuring comfort, health, and productivity in educational spaces. The modern educational landscape is increasingly reliant on technology for teaching and learning. With the rising significance of technology in education, computer labs serve as central spaces for learning and development. These labs facilitate access to digital resources, interactive learning platforms, and collaborative tools, making it imperative to optimize these environments for comfort and well-being. Ergonomically designed furniture in computer labs is essential for several reasons. Firstly, it enhances comfort and reduces the risk of

musculoskeletal disorders among students. Sitting for extended periods in poorly designed chairs can lead to back pain, neck strain, and other physical discomforts. Ergonomic chairs with adjustable features such as lumbar support, armrests, and seat height help students maintain proper posture and reduce strain on their bodies. Moreover, anthropometrically suited furniture caters to the diverse physical dimensions of students, ensuring that everyone has a comfortable and supportive seating arrangement (Anik Kumar Saha, 2024). By accommodating different body sizes and shapes, ergonomic furniture promotes inclusivity and accessibility in educational spaces. Furthermore, well-designed furniture contributes to improved focus and concentration. Comfortable seating enables students to concentrate better on their tasks without distractions caused by discomfort or physical fatigue. This, in turn, enhances productivity and learning outcomes in computer labs. Additionally, ergonomic furniture promotes overall well-being and student health (Roopa Rao, 2018). By reducing the risk of physical ailments associated with prolonged sitting, such as obesity and cardiovascular problems, schools can create healthier learning environments. When students are comfortable and supported, they are more likely to engage actively in their studies and adopt healthy habits. In conclusion, the integration of ergonomically designed furniture in computer labs is essential for optimizing educational spaces and promoting student well-being. By prioritizing comfort, health, and productivity, schools can create conducive learning environments that empower students to thrive in the digital age (Roopa Rao, 2018).

Significant variations in body dimensions, particularly between genders and ages, were noted among students aged 10 - 16. Existing furniture exhibited mismatches with anthropometric measurements, highlighting the need for more size variety to accommodate diverse body types while evaluating classroom furniture in Solapur, Maharashtra (Dr. S. V. Kalurkar, 2017). Similarly, 'Design of Ergonomically Fit Classroom Furniture of Primary Schools of Bangladesh,' found significant mismatches between anthropometric data from 300 primary school students and furniture dimensions, particularly in the seat and desktop heights. These mismatches contribute to musculoskeletal disorders, emphasizing the importance of designing furniture based on anthropometric measurements to enhance comfort and prevent health issues (M. S. Parvez, 2018). Furthermore, in Greece, 'Classroom furniture dimensions and anthropometric measures in primary schools,' highlighted the significance of proper posture during extended periods of sitting in school and emphasized the importance of furniture that supports correct posture, especially for children, as habits formed during childhood are challenging to change later. Specific anthropometric measurements like popliteal height and elbow height were identified as crucial for designing school furniture that facilitates proper sitting posture (Georgia Panagiotopoulou 1, 2004).

Given these findings, conducting the proposed study in Mumbai, Maharashtra is essential to address similar challenges faced by students in urban educational settings. By evaluating the compatibility between students' anthropometric data and school computer lab furniture dimensions, the study aims to identify areas for improvement and inform the design of furniture that promotes ergonomic comfort and enhances learning outcomes.

Objectives:

This study was conducted in Mumbai, Maharashtra, to investigate the correlation between student anthropometric measurements and furniture dimensions in school laboratories to improve comfort, ergonomics, and productivity holds significant implications for the health, well-being, and academic success of students by ensuring that school furniture is tailored to their anthropometric characteristics, thereby creating a conducive learning environment conducive to their needs.

The Specific Objectives are to: (i) collect appropriate anthropometric measurements from primary and secondary grade students; (ii) collect the dimensions of furniture in computer labs; (iii) compare the dimensions of computer lab furniture with the anthropometric data gathered for each section; and (iv) examine the compatibility between anthropometric data and furniture dimensions.

Methodology

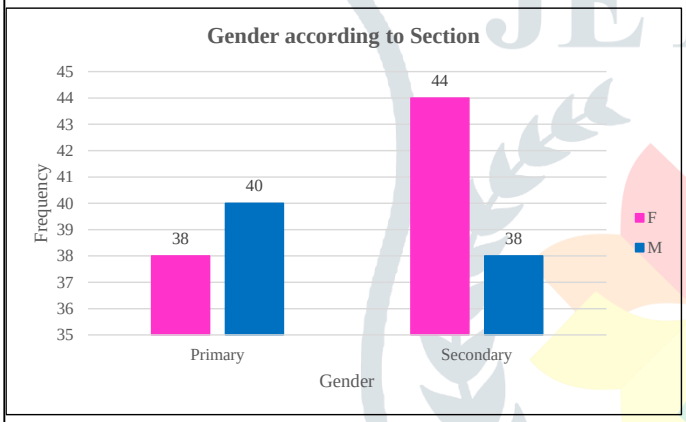
Descriptive correlational research was conducted among 160 students from 8 schools, covering both primary and secondary sections. Sampling techniques included convenient and purposive methods. Inclusion criteria encompassed students from primary and secondary sections, while exclusion criteria involved those with physical disabilities that could affect anthropometric measurements. Before conducting measurements and surveys, informed consent was obtained from students' guardians.

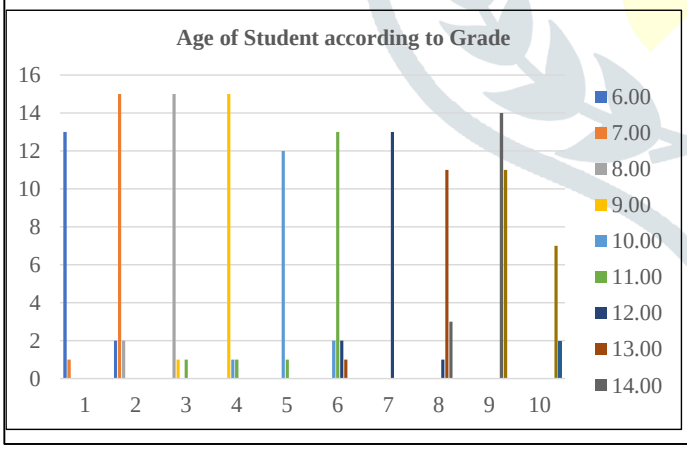
The tools employed for data collection included: An Anthropometer for accurately measuring height; a soft measure tape for measuring various body circumferences; an Anthropometry Stool to ensure consistent seating positions while taking measurements; A customized self-constructed Questionnaire to collect data on students' ergonomic experiences and preferences. Additionally, existing furniture measurements in the computer lab were collected to correlate them with the collected anthropometric data of students. The collected data was coded systematically and analyzed using MS Excel. Simple statistics were employed to analyze the data.

Results and Discussion:

160 students from both primary and secondary sections of 8 different schools, were randomly selected. Both girls 86(56.8%) and boys 74(In the primary section, there were a total of 78 students, comprising 38 girls and 40 boys. In the secondary section, there were 82 students, with 48 girls and 34 boy.15(9.3%) students were aged 6 years, 16(10%) 7 years, 17(10.6%) of 8 years, and 16(10 %) were aged 9 years. 15 (9.3%) students were the age of 10 years,16 (10%) students were the age of 11 years,16(10%) Students were the age of 12 years, 12(7.5%) students were of the age of 13 years, 17 (10.6%)students were the age of 14 years,18 (11.2%) students were the age of 15 years and lastly 2 (1.2%) students were the age of 16 years.

Fig 1: Demographic Profile of the Sample





- Average age of the sample is 10.6 years.
- Equal number of male and female students were selected
- Informed consent was taken from the participant as well as the school authorities.
- Students belonged to Grade 1 till Grade 10.
- Measurements of the computer lab was also recorded.

No. of participants from each School/Section			
Section / School Code	Primary	Secondary	Total
School A	10	10	20 (12.5%)
School B	10	10	20 (12.5%)
School C	10	10	20 (12.5%)
School D	10	10	20 (12.5%)
School E	8	12	20 (12.5%)
School F	10	10	20 (12.5%)
School G	10	10	20 (12.5%)
School H	10	10	20 (12.5%)
Total	78	82	160 (100%)

Anthropometry: Considering anthropometric dimensions is vital when designing furniture for students (Roopa Rao, 2018) because it:

- enhances comfort and ergonomics by supporting proper posture and reducing strain.
- promotes accessibility and inclusivity by accommodating diverse physical abilities.
- boosts productivity and focus by providing comfortable seating options.
- supports students' health and well-being by minimizing the risk of musculoskeletal issues.

- allows for customization and personalization to suit individual preferences and needs, creating a conducive learning environment.

Furniture Dimension	Anthropometric Dimensions of students	Design Requirements	Anthropometric Considerations
Table/Desk	Shoulder breadth		95th percentile
	Upper limb length	Desk depth	95th percentile
	Standing height	Desk Height	-
	Stature		-
	Sitting height	Bench Sitting Height	5th percentile
	Sitting elbow height	Elbow Rest Height	Optional
	Sitting shoulder height	Backrest Height	95th percentile
	Knee height	Storage below the desk	95th percentile
Bench/Chair	Buttock-popliteal length	Bench depth	95th percentile
	Sitting eye height	Monitor Height	5th percentile
	Thigh clearance	Storage height below the Desk	95th percentile
	Hip breadth	For width of Bench	95th percentile
	Popliteal height	Sitting Height	5th percentile

Percentiles: The number that separates the lowest 5% of observations from the rest is known as the 5th percentile; the median and 50th percentile are the same; and the 95th percentile surpasses all values except for the 5th %. Educational spaces, and optimizing computer lab furniture are vital for student comfort and productivity. Anthropometric measurements, represented through percentiles, offer insights into designing furniture that accommodates diverse body sizes (R. K. Sharma et al., 2013).

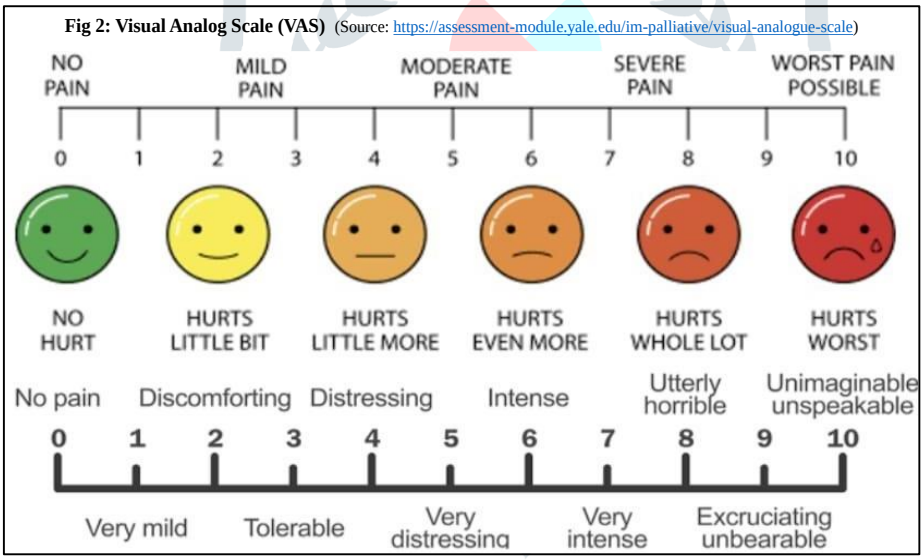
- Shoulder Breadth (95th percentile): Ensures adequate spacing between chairs for students with broader shoulders, fostering inclusivity and comfort
- Upper Limb Length (95th percentile): Desks at suitable heights prevent discomfort for students with shorter upper limbs.
- Standing Height (95th percentile): Provides adequate headroom for taller students, respecting physical diversity.
- Stature: Serves as a reference point for space utilization and design decisions.
- Sitting Height (5th percentile): Promotes ergonomic comfort during prolonged computer use.
- Sitting Elbow Height (50th percentile): Desks positioned for comfortable interaction with peripherals.
- Sitting Shoulder Height (95th percentile): Aligns backrest or armrest height with shoulder height for proper support.
- Knee Height (95th percentile): Ensures proper alignment and comfort in seating.
- Buttock Popliteal Length (95th percentile): Seat depth minimizes pressure points and discomfort.
- Sitting Eye Height (5th percentile): Monitors positioned for optimal viewing angles and reduced eye strain.
- Thigh Clearance (95th percentile): Provides space for thighs without restriction.
- Hip Breadth (95th percentile): Accommodates varying body sizes for ease of movement
- Popliteal Height (5th percentile): Adequate clearance under desks for lower limb comfort.

Table 2: Anthropometric Considerations for School Lab Furniture			
Furniture Dimensions	**Anthropometric Dimensions**	**Design Requirements**	**Anthropometric Considerations**
Table/Desk	Shoulder breadth		95th percentile
	Upper limb length	Desk depth	95th percentile
	Standing height	Desk Height	-
Bench/Chair	Sitting height	Bench SittingHeight	5th percentile
	Sitting elbow height	Elbow Rest Height	Optional
	Sitting shoulder height	Backrest Height	95th percentile
	Knee height	Storage below thedesk	95th percentile
	Buttock-popliteal length	Bench depth	95th percentile
	Sitting eye height	Monitor Height	5th percentile
	Thigh clearance	Storage heightbelow Desk	95th percentile
	Hip breadth	For the width of the Bench	95th percentile
	Popliteal height	Sitting Height	5th percentile

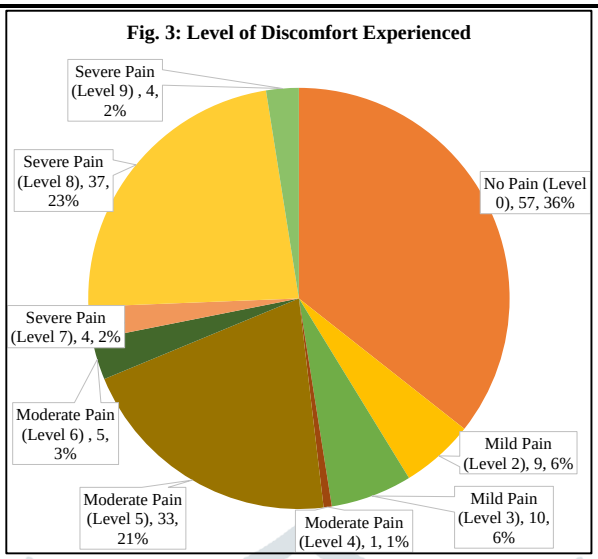
VAS (Visual Analogue Scale)

The Visual Analog Scale (VAS) is a tool used to measure subjective experiences, such as discomfort or pain, by having participants mark their perception on a continuous line. In the context of discomfort levels among primary and secondary students related to school furniture, the VAS is particularly apt for this study due to its simplicity, ease of use, and ability to capture subjective experiences along a continuum.

Fig 2: Visual Analog Scale (VAS) (Source: https://assessment-module.yale.edu/im-palliative/visual-analogue-scale)



Students can easily indicate their level of discomfort by marking a point on the line, allowing for quick and efficient data collection. Additionally, the VAS provides a standardized way to quantify discomfort, enabling researchers to analyze and compare the data effectively. The VAS offers a practical and reliable method for recording discomfort levels among students, making it well-suited for this study's objectives.

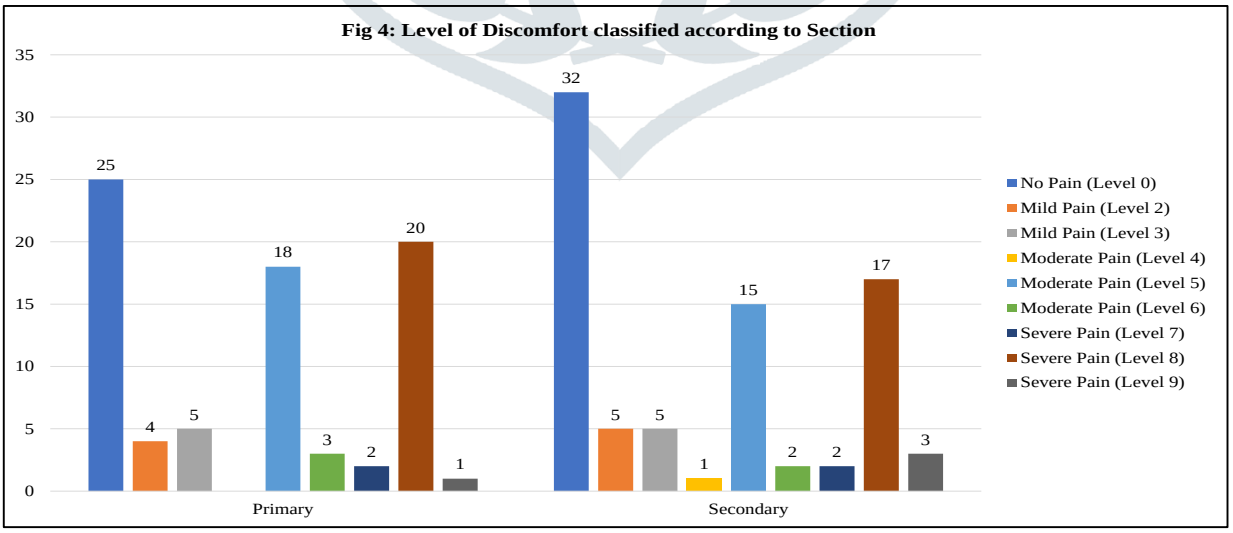


A Visual Analog Scale (VAS), is a well-established psychometric tool commonly employed in pain assessment surveys to discern different levels of pain perception among individuals. The findings revealed that a substantial proportion of students experienced considerable discomfort, with 32% reporting severe pain at level 7 on the VAS and an additional 26% reporting even higher levels of severe pain at level 8. This suggests a significant prevalence of discomfort among the student population, warranting further investigation into potential contributing factors and interventions to alleviate their pain and enhance their overall well-being.

Discussion

The results of this study show that a considerable number of students are experiencing discomfort, as indicated by the distribution of pain levels among those surveyed. Although most students reported no pain, there is a notable presence of mild to severe pain, particularly at levels 5 to 8 on the Visual Analog Scale (VAS). This suggests that there is a need for further investigation into the factors contributing to this discomfort and the implementation of interventions to address it, highlighting the importance of prioritizing student well-being to ensure a conducive learning environment.

At the school level, it is essential to develop specific plans aimed at reducing discomfort among students. This



includes allocating ample resources for implementing improvement standards, especially concerning seating and equipment in classrooms and computer labs. Regular assessments should be conducted to track progress and make necessary adjustments to the strategies provided through this study to ensure its effectiveness.

In addition to this, organizing training sessions for teachers and staff members to recognize signs of discomfort and implement supportive measures is crucial. Teachers can play a pivotal role in advocating for good posture and encouraging students to take breaks when necessary. By fostering a culture of proactive care and support, the researchers aim to create an environment where students feel empowered to voice their needs regarding pain or discomfort.

On an individual level, educating students about the importance of maintaining good posture and taking breaks to prevent pain is paramount. Students must be encouraged to speak up about any discomfort they may experience and provide channels for reporting such issues. Additionally, fostering a sense of collective responsibility among students to watch out for one another and offer support when needed contributes to cultivating a positive and inclusive school environment.

Addressing student discomfort is essential for creating a conducive learning environment. Implementing interventions at both the school and individual levels and fostering a culture of proactive care and support, will ensure that students feel comfortable and empowered to excel academically.

The distribution of pain levels among the students surveyed indicates a significant portion experiencing discomfort. While the majority report no pain, there is a notable presence of mild to severe pain, particularly at levels 5 to 8 on the VAS scale. This highlights the need for further investigation into the factors contributing to such discomfort and the implementation of interventions to address it. It's crucial to prioritize student well-being to ensure a conducive learning environment (Rao, 2020).

Recommendations Based on the Results:

An innovative product that could address the discomfort experienced by students in school settings, particularly in computer labs, could be an adjustable ergonomic chair with integrated posture support features. This chair would be designed to accommodate a wide range of anthropometric measurements, ensuring a comfortable fit for students of different ages and body types.

Key features of this chair could include:

- Adjustable seat height: Allows students to customize the height of the chair to ensure proper alignment with the computer workstation, reducing strain on the lower back and legs.
- Lumbar support: Built-in lumbar support to promote a healthy spine curvature and reduce the risk of back pain, especially during prolonged sitting sessions.
- Adjustable armrests: Armrests that can be adjusted in height and width to provide support for the arms and shoulders, promoting proper posture and reducing muscle fatigue.
- Swivel and tilt mechanism: A swivel and tilt mechanism that allows students to easily adjust the chair position to find the most comfortable seating angle, reducing pressure points and discomfort.
- Breathable and supportive upholstery: High-quality upholstery materials that offer both comfort and support, with breathable properties to prevent overheating during long periods of use.
- Additionally, incorporating built-in sensors or feedback mechanisms into the chair design could provide real-time posture feedback to students, reminding them to maintain proper posture and take breaks when necessary. This interactive feature could help raise awareness about the importance of ergonomics and encourage healthier sitting habits among students.

An adjustable ergonomic chair with integrated posture support features would address the mismatch between students' anthropometric measurements and existing furniture dimensions, promoting comfort, productivity, and overall well-being in school environments.

For the successful execution of the proposed design suggestions, the active involvement of all stakeholders is imperative. Here are some recommendations for engaging stakeholders in the process:

To the Education Ministry:

i. Enforce guidelines for school furniture dimensions based on anthropometric data to ensure a proper ergonomic fit for students.
ii. Provide training workshops for teachers and school staff on recognizing signs of discomfort and promoting proper posture among students.
iii. Allocate funds for the procurement of adjustable ergonomic furniture and equipment for school computer labs.

To School Authorities:

i. Conduct regular assessments of school furniture and computer lab setups to identify areas for improvement in ergonomic design.

ii. Integrate lessons on proper posture and ergonomics into the school curriculum to raise awareness among students.
iii. Encourage parents to support their children in maintaining good posture at home and provide feedback on any discomfort experienced while using school furniture.

To Parents:

i. Create a supportive home environment with ergonomically designed study areas to reinforce good posture habits learned at school.
ii. Limit children's screen time and encourage breaks to prevent prolonged periods of sitting and potential musculoskeletal issues.
iii. Advocate for the implementation of ergonomic standards in schools and actively engage with school authorities to address any concerns regarding furniture comfort.

To Children:

i. Practice sitting with feet flat on the floor, back against the chair, and shoulders relaxed to maintain good posture.
ii. Remember to take regular breaks from sitting, stretching, and moving around to prevent stiffness and muscle fatigue.
iii. Speak up if discomfort or pain is experienced while using school furniture, and seek assistance from teachers or parents to address the issue promptly.

Scope of the Study

The study results provide valuable insights for schools, educators, and facility managers to make informed decisions toward purchasing better student anthropometric accommodation. Teachers can apply the knowledge gained to promote good posture and comfort among students. Furthermore, the findings can inform the development of guidelines and standards for designing classroom furniture that aligns with student anthropometric measurements. Schools can utilize the study's insights to produce environments conducive to student well-being and academic performance.

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