

**ORIGINAL ARTICLE**

# Ergonomic Classroom Design to Improve Student Comfort and Engagement

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**ABSTRACT** - This study investigates ergonomic factors influencing student comfort and learning engagement in Malaysian secondary-school classrooms, addressing the gap in local studies that examine physical learning environments from an ergonomic perspective. A mixed-methods approach involving 48 students and 14 teachers was used to assess discomfort sources, furniture suitability, and classroom environmental conditions. Findings reveal that non-ergonomic seating, spatial constraints, and inadequate environmental support significantly affect posture, concentration, and wellbeing. The study highlights the need for evidence-based ergonomic interventions to enhance classroom comfort and improve student engagement.

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## INTRODUCTION

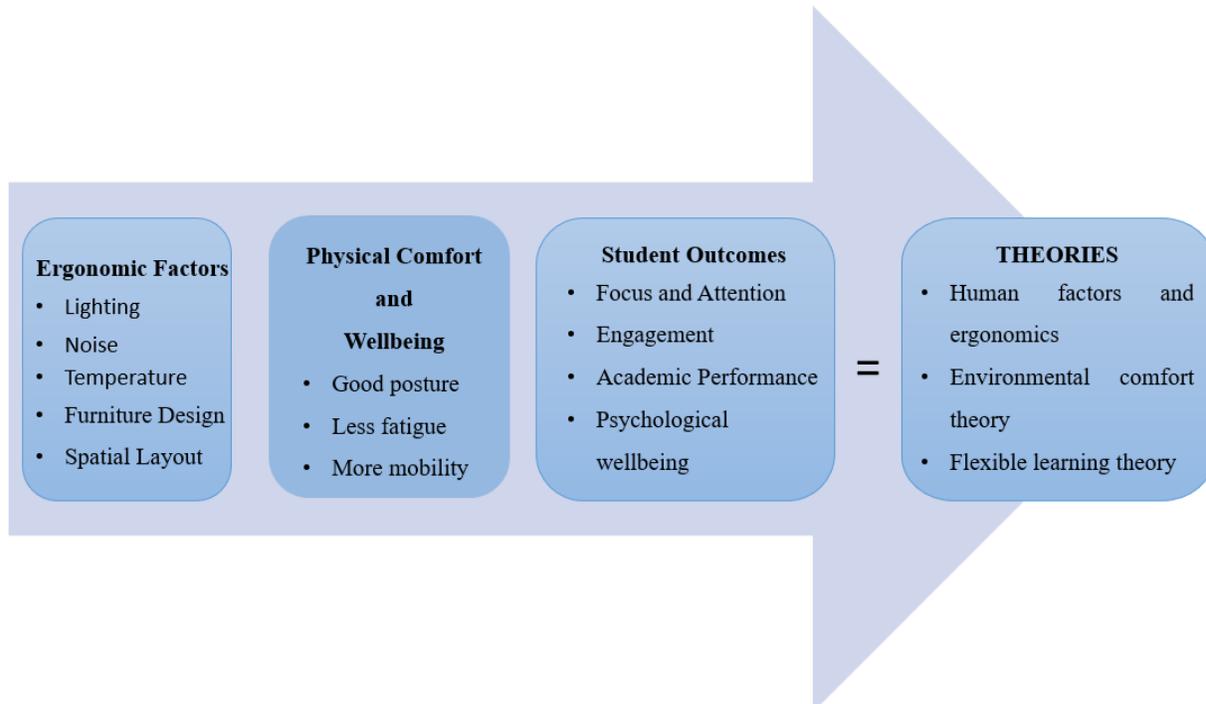
The physical learning environment is increasingly acknowledged as a significant factor affecting students' academic performance and overall wellbeing [3; 8]. Although pedagogical strategies and curriculum design have historically garnered considerable attention, the influence of classroom furniture on student comfort and engagement is still insufficiently examined. Many Malaysian secondary schools, especially in rural areas like Sibu, still utilise outdated and non-ergonomic furniture, which do not align with students' anthropometric needs [2; 9].

Comfort and physical wellbeing are essential prerequisites for effective learning. Students' discomfort from rigid seating or suboptimal classroom arrangements negatively impacts their focus, engagement in lessons, and information retention. Poor posture and limited mobility impair concentration and adversely influence cognitive performance and long-term health outcomes. In contrast, learning environments that incorporate ergonomic features, such as adjustable seating, lumbar support, and appropriately sized desks, enhance posture, minimise fatigue, and create a more supportive and engaging atmosphere for learning.

Although classroom ergonomics has been examined in various international contexts, empirical research focusing on Malaysian secondary schools particularly rural and under-resourced areas remains limited. This study contributes originality by integrating a mixed-methods assessment of ergonomic conditions with real user feedback from both teachers and students across diverse school environments in Sibu, Sarawak. The inclusion of detailed anthropometric environment mismatches, spatial constraints, and user-identified ergonomic priorities provides data that have not been previously documented at the secondary-school level in Malaysia. In addition, the study proposes a context-specific ergonomic model that links environmental discomfort factors to wellbeing and learning engagement, offering a framework that can inform local school design standards and future ergonomic interventions.

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Figure 1 Background of Research illustrates the progressive relationship between ergonomic factors in classroom environment and students learning outcomes. This conceptual model identifies five key physical elements which is the lighting, noise, temperature, furniture design and spatial layout. As foundational contributors to students' physical comfort and overall wellbeing. When these factors are optimally designed, the support better posture, reduce fatigue and enhance mobility within the classroom setting.



**Figure 1.** Background Research

Improved physical comfort not only reduces musculoskeletal strain but also supports students' emotional stability, mental alertness, and overall sense of safety. These relationships align with Human Factors and Ergonomics (HFE) Theory, which emphasizes the need for classroom furniture to fit students' physical capabilities and anthropometric requirements. When furniture is ergonomically appropriate, students experience less discomfort, enabling better posture, sustained attention, and active engagement during lessons.

In addition, Flexible Learning Space Theory highlights the importance of adaptable and spacious classroom layouts. Flexible seating and open movement areas encourage collaboration, improve visibility, and reduce the psychological stress associated with cramped or rigid environments. Such layouts also support diverse learning activities, allowing students to participate more actively and meaningfully.

To further frame this study within established educational and psychological perspectives, three additional theories are considered. Maslow's Hierarchy of Needs underscores that meeting students' physiological and safety needs through ergonomic furniture and supportive seating arrangements is foundational for higher-level learning and engagement. Cognitive Load Theory highlights that reducing discomfort and postural strain minimizes extraneous cognitive load, allowing students to allocate more mental resources toward learning tasks [10]. Finally, Environmental Psychology Theory emphasizes how the physical environment influences behavior, cognition, and emotions, reinforcing the importance of well-designed classroom furniture in promoting attention, collaboration, and academic performance.

Together, these theoretical foundations show that classroom furniture and seating design play a critical role in shaping students' cognitive functioning, motivation, and academic performance. This study adopts a human-centred perspective by identifying discomfort and environmental stressors related specifically to seating and furniture in conventional Malaysian classrooms. Through a mixed-methods approach combining surveys and classroom observations, the research provides practical, data-driven insights to guide ergonomic improvements, with the ultimate goal of designing inclusive, health-conscious learning spaces that prioritize student comfort and wellbeing.

Human needs are structured in a hierarchy, starting from physiological needs and progressing to safety, social belonging, esteem, and self-actualization [7]. In the classroom context, ergonomic furniture addresses students' physiological and safety needs by ensuring comfort and proper posture, which forms the foundation for higher-level learning needs such as engagement, collaboration, and cognitive development.

Cognitive Load Theory suggests that working memory has a limited capacity, and learning is optimized when extraneous load is minimized [10]. Poorly designed classroom furniture or constrained spaces can increase extraneous cognitive load by causing discomfort, distraction, or fatigue. By implementing ergonomic furniture, extraneous load is reduced, allowing students to allocate more cognitive resources toward understanding and processing learning materials effectively.

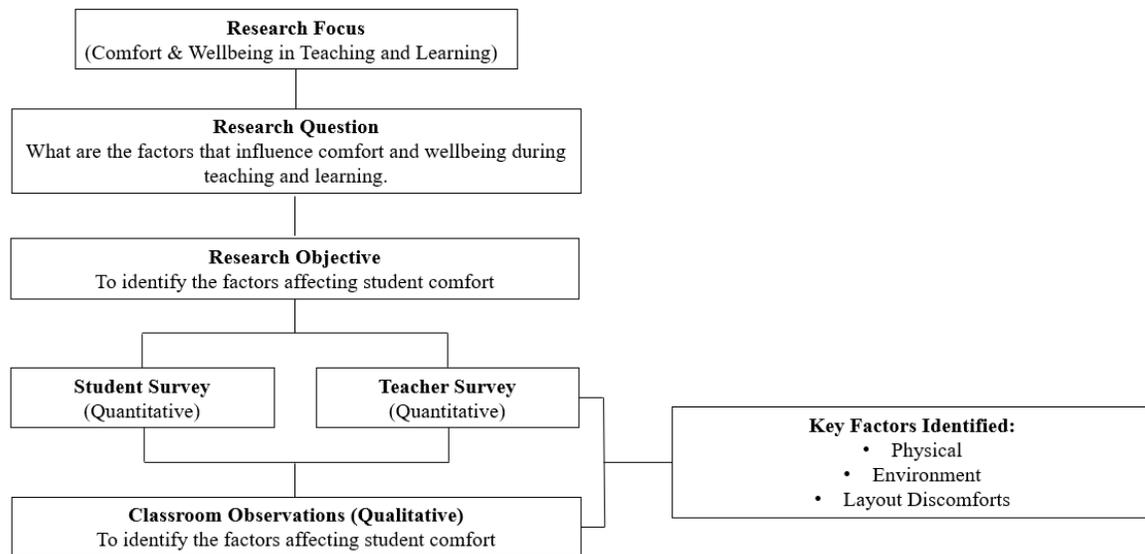
Environmental psychology emphasizes the impact of physical surroundings on human behavior, cognition, and emotions. Classroom environments that incorporate ergonomic design, appropriate lighting, and flexible seating arrangements can enhance students' attention, motivation, and interaction. Such supportive environments contribute to improved learning performance and overall well-being.

## MATERIALS AND METHODOLOGY

This research employs a mixed-methods approach to investigate environmental factors, particularly furniture design and classroom layout, that affect student comfort and wellbeing. The study provides a comprehensive perspective on students' physical learning conditions through the integration of quantitative and qualitative methods. This aligns with the research objective, which is to identify the factors influencing student comfort and wellbeing in the context of teaching and learning. The research question is: What factors affect comfort and wellbeing during teaching and learning?

Quantitative data were collected through structured questionnaires administered to students and teachers from eight selected secondary schools in Sibu, Sarawak. A total of 14 teachers and 48 students participated in the survey. The questionnaire employed a Likert scale to assess key ergonomic variables, including posture comfort, desk and chair design, lighting, noise levels, air ventilation, and spatial arrangement. Participants were asked to rate their comfort levels, share their experiences with existing classroom furniture, and report any physical discomfort experienced during lessons. This data collection aimed to evaluate how various elements of the classroom environment influence students' physical wellbeing and learning engagement.

The responses collected through Google Forms were compiled and analysed using descriptive statistical tools, including means, percentages, and standard deviations, to identify common patterns and discomfort factors. Frequency analysis was employed to determine the most reported ergonomic issues, such as poor posture support, inadequate lighting, or high noise levels. The results provide empirical insights into the environmental stressors affecting student wellbeing within Malaysian classroom settings.



**Figure 2.** Research Area

Alongside survey data, qualitative insights were obtained through on-site classroom observations. The researcher performed visual inspections and photographic documentation to evaluate furniture types, spatial arrangements, lighting conditions, noise levels, and air ventilation. The observations provided context for student feedback and were instrumental in identifying discrepancies between furniture dimensions and students' anthropometric requirements. The combination of both methods facilitated data triangulation, thereby improving the study's validity and reliability.

An updated Research Area Flowchart was created to clarify the research scope, consisting of three main components: (1) Learning Environment Factors, (2) Sources of Physical Discomfort, and (3) Impact on Wellbeing. The initial component encompasses variables including lighting, seating posture, desk height, ambient noise, and ventilation. These factors are associated with discomfort indicators, including musculoskeletal strain, back pain, and fatigue, which subsequently influence students' attentiveness, motivation, and engagement in the classroom. The flowchart illustrates the cause-and-effect relationship between environmental design and student comfort, thereby supporting the rationale for ergonomic intervention.

The sample consisted of 48 students and 14 teachers, selected through purposive sampling to ensure representation from both rural and urban educational environments. Ethical protocols were strictly followed; all participants were informed about the purpose of the study and assured of anonymity and voluntary participation. This methodology aimed to gather direct user feedback and link it to identified ergonomic deficiencies, thereby producing practical, user-informed recommendations. Table 1 presents the demographic profile of the respondents, detailing their gender, school location, and age groups.

**Table 1.** Demographic Profile of Respondents

Category	Students	Teachers
Gender		
Male	21	7
Female	27	7
School Location		
Urban	34	10
Rural	14	4
Age Group		
Teenagers (13 – 17)	48	-
Adults (20 – 50)	-	14

This methodological framework facilitates the identification of key environmental factors influencing student comfort and connects them to broader implications for student health and academic performance. The findings aim to guide ergonomic classroom redesign and foster student-centred learning environments, emphasising the importance of physical wellbeing for educational success.

## RESULTS AND DISCUSSION

It discusses findings pertinent to the initial research objective and question: identifying factors that influence student comfort and well-being in the context of teaching and learning. Data were collected via surveys administered to students and teachers, supplemented by classroom observations. The analysis identifies primary sources of discomfort and environmental factors that affect students' physical and emotional wellbeing, subsequently influencing their focus, motivation, and learning behaviours.

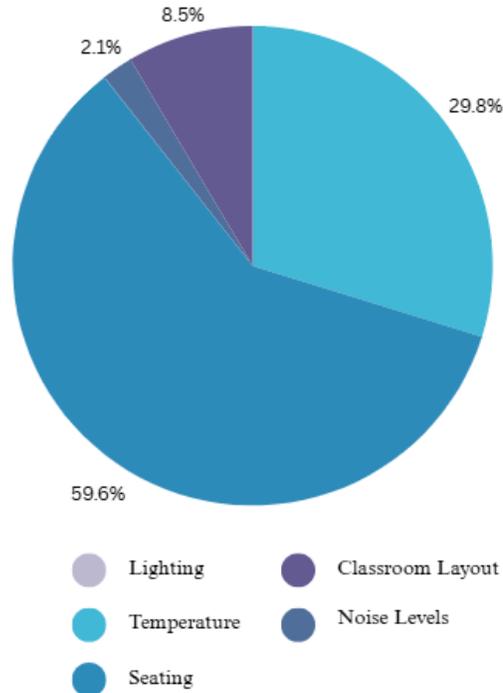
Recent studies have increasingly recognized the importance of ergonomics in classroom design, particularly in relation to student comfort and engagement. Conducted a comprehensive investigation into the impact of non-ergonomic seating on student health and cognitive performance [4]. Their findings revealed that poorly designed school furniture contributes to increased fatigue, postural discomfort, and reduced concentration levels during lessons. The study emphasized the necessity of ergonomically appropriate seating to support students' physical well-being and maintain sustained focus throughout academic activities. These insights provide a foundational basis for the present study, which aims to explore similar ergonomic concerns within the Malaysian secondary school context.

To better understand the primary sources of physical discomfort experienced by students in the classroom, a quantitative analysis was conducted based on several ergonomic factors. These included seating, temperature, noise levels, lighting, and classroom layout. The data collected from students' responses were compiled into a pie chart to illustrate the proportion of discomfort attributed to each factor. This visual representation provides clearer insight into which environmental aspects most significantly affect students' comfort and engagement during lessons.

Figure 3 illustrates that seating is the primary factor contributing to discomfort at 59.6%, followed by temperature at 29.8%, noise levels at 8.5%, and classroom layout at 2.1%. The findings highlight the significant impact of physical discomfort, primarily due to inadequately designed seating, on students' classroom experiences. The findings align with those of [4], who noted that non-ergonomic seating may hinder concentration and elevate fatigue levels. This highlights the importance of ergonomically suitable furniture in enhancing students' physical wellbeing and maintaining their concentration.

To further explore potential solutions for enhancing classroom comfort, students were asked to indicate their preferred ergonomic interventions. The survey provided multiple options related to furniture

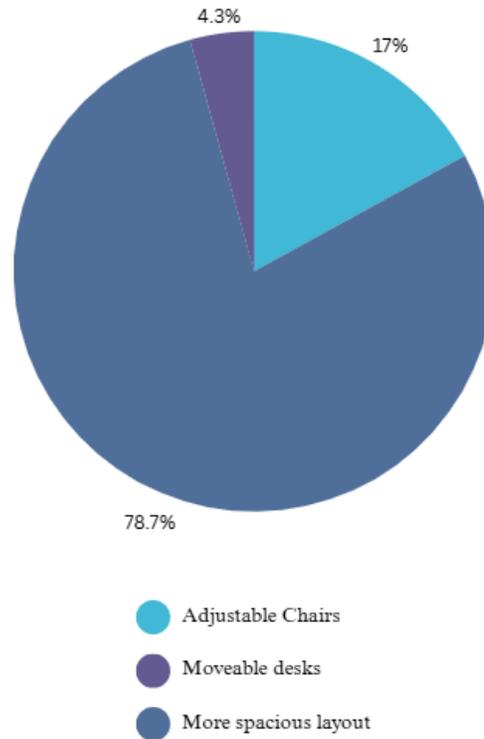
and spatial arrangement, allowing students to select the features they believed would most improve their physical comfort during lessons. The collected responses offer valuable insight into user-informed design priorities and highlight the types of environmental modifications students feel would best support their learning experiences.



**Figure 3.** Key Contributing to Discomfort in the Classroom

Figure 4 illustrates the interventions that students prefer to improve classroom comfort. A significant proportion (78.7%) expressed a preference for a more spacious layout, while requests for adjustable chairs constituted 17%, and moveable desks accounted for 4.3%. The preference for spatial flexibility highlights the significance of classroom design in facilitating movement, decreasing clutter, and minimising restrictive layouts, principles essential to ergonomic learning environments. The findings conform to ergonomic principles that advocate for flexible classroom layouts aimed at minimising physical discomfort and accommodating various educational activities.

In evaluating how classroom design affects student engagement, the study gathered student feedback on specific physical and spatial barriers within the learning environment. The aim was to identify which classroom conditions most hinder participation, collaboration, and comfort during lessons. Respondents were presented with several common classroom issues and asked to select those that most negatively influenced their ability to move, engage, and interact effectively. The results offer important insights into how spatial limitations and seating configurations affect students' overall learning experience.

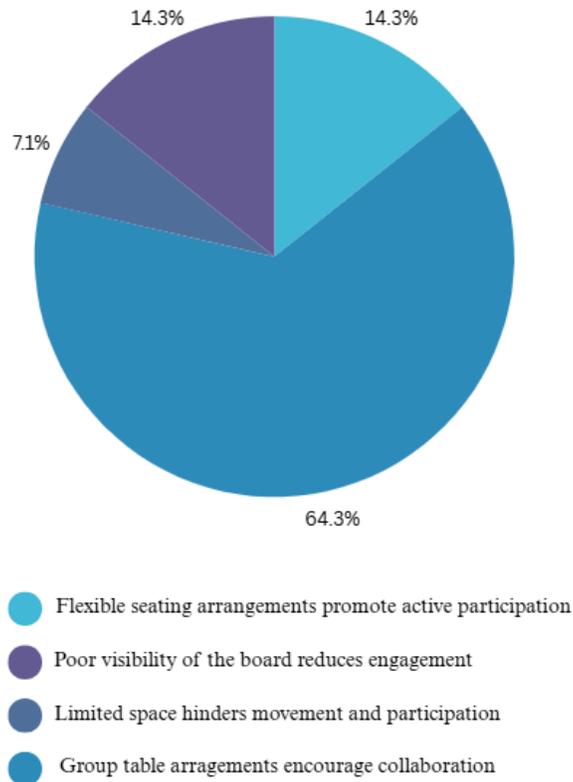


**Figure 4.** Preferred Change in Classroom Furniture for Improved Comfort

Figure 5 indicates that 64.3% of respondents identified limited space as the main factor obstructing movement and participation. This was followed by flexible seating arrangements at 14.3%, poor visibility of the board at 14.3%, and group table arrangements at 7.1%. The findings underscore the significant impact of spatial constraints on student engagement and physical comfort. Students with restricted movement or those who are compelled to adjust to rigid furniture arrangements exhibit lower levels of active participation and a higher susceptibility to fatigue.

The predominance of seating-related discomfort underscores the critical role of ergonomically designed furniture in supporting student wellbeing. Poorly fitted chairs and fixed desks not only cause physical strain but also affect cognitive engagement and learning efficiency, as predicted by Cognitive Load Theory [10]. Students experiencing discomfort may expend more mental energy managing posture and fatigue, leaving fewer resources for attention, problem-solving, and active participation. These findings also align with Maslow's Hierarchy of Needs, emphasizing that addressing basic physiological and safety requirements such as comfortable seating is essential before higher-level learning and motivation can be fully achieved [7].

The results highlight clear design priorities for classroom interventions. Students' preference for spacious layouts, adjustable chairs, and moveable desks indicates a need for flexible and adaptable learning environments that accommodate diverse learning activities. Implementing these ergonomic solutions can reduce musculoskeletal strain, facilitate movement and collaboration, and enhance overall comfort. Classroom redesigns informed by these findings can create inclusive, student-centered spaces where physical wellbeing supports active engagement and participation in lessons.



**Figure 5.** Main Factors Influencing Students' Well-being in the Classroom

From a policy perspective, the study provides evidence to guide standards for school furniture and classroom layout in Malaysian secondary schools. Educational authorities could establish minimum ergonomic requirements for desks, chairs, and classroom space to ensure students' physical health and learning effectiveness. These findings are particularly relevant for rural and under-resourced schools, where furniture is often non-adjustable and space is limited. By prioritizing ergonomics in both design and procurement decisions, schools can foster healthier, more engaging learning environments that positively influence academic outcomes, motivation, and long-term wellbeing.

## FUTURE RESEARCH

To improve the generalisability of the results, future research should broaden the scope of this study by incorporating larger and more varied samples from various Malaysian areas and educational levels. To assess the long-term effects of ergonomic classroom design on students' physical health, posture, and learning engagement, longitudinal studies are advised. Stronger empirical proof of ergonomic furniture solutions' impacts on cognitive load, comfort, and academic performance would also come from experimental or quasi-experimental research that execute and assess these interventions, such as flexible desk configurations and adjustable seats. To increase the precision and dependability of results, it is also advised to incorporate environmental measures and objective ergonomic evaluation instruments with self-reported data. To further guide the creation of student-centered and ergonomically conducive learning environments, future studies may examine the connection between classroom ergonomics and particular learning abilities, such as cooperation, critical thinking, and self-directed learning.

## CONCLUSION

This study successfully addressed the research objective and question by identifying the key factors affecting student comfort and wellbeing in secondary school classrooms, with a particular focus on furniture and seating ergonomics. Surveys of students and teachers, complemented by classroom observations, revealed that non-ergonomic furniture including hard chairs, fixed desks, and inflexible layouts significantly contributes to physical discomfort, poor posture, and fatigue. These issues were found to negatively influence students' attentiveness, engagement, and overall learning performance.

Overcrowded seating and the lack of adjustable or supportive furniture were reported as major stressors, limiting mobility and collaborative interaction. Feedback from both students and teachers emphasized the need for ergonomic improvements, such as adjustable chairs, back support, and flexible seating arrangements to facilitate active and collaborative learning.

The findings underscore the importance of ergonomically designed classrooms in promoting concentration, engagement, and academic achievement. Prioritizing physical comfort not only supports cognitive performance but also enhances students' emotional wellbeing and motivation in the learning process.

This study highlights the need for reevaluating classroom furniture and layout in Malaysian secondary schools, particularly in rural areas where resources may be limited. Implementing ergonomic principles provides a foundation for creating healthier, inclusive, and student-centred learning environments. The results offer a practical basis for future design interventions and policy initiatives that integrate student wellbeing into educational planning and classroom design.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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