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INFLUENCE OF ERGONOMIC CLASSROOM DESIGN ON STUDENTS' LEARNING OUTCOME IN THE FEDERAL POLYTECHNIC, ILARO.

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ABSTRACT: *In the contemporary educational landscape, the optimization of the learning environment is paramount to fostering academic excellence and ensuring student well-being. This study investigated the influence of classroom ergonomics on students' learning outcomes at Federal Polytechnic, Ilaro, Ogun State, specifically focusing on physical, environmental, and cognitive dimensions. A survey research design was adopted, and the population comprised 6,966 ND II and HND II students of The Federal Polytechnic, Ilaro, Ogun State. A sample size of 346 was selected using Krejuice & Morgan's Sample Size Table. Three hypotheses were formulated and an online structured questionnaire was used to gather data from the respondents. The data were analyzed using simple linear regression. The findings revealed that all the three ergonomic factors have a statistically significant influence on students' learning outcomes (p-value = 0.000). Physical ergonomics accounted for 17.3% of the variance in learning outcomes (Adjusted R^2 = 0.173, β = 0.420, t = 6.920). Environmental ergonomics showed a stronger influence at 39.2% (Adjusted R^2=0.392, β = 0.629, t = 12.071). Most notably, cognitive ergonomics emerged as the most critical factor, explaining 46.9% of the variance (Adjusted R^2=0.469, β = 0.686, t = 14.093). The study concluded that academic achievement is not solely dependent on student's effort or instruction given in the classroom but also influenced by the holistic design of the learning environment. It was recommended among others, that the institution should prioritizes instructional design training and environmental upgrades to maximize student performance.*

KEYWORDS: Cognitive Ergonomics, Environmental Ergonomics, Physical Ergonomics, Students' Learning Outcome, The Federal Polytechnic Ilaro.

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INTRODUCTION

The concept of ergonomic classrooms has gained increasing attention in educational research as schools and higher institutions seek to optimize learning environments that align with human capabilities. Ergonomics in education extends beyond furniture design to include environmental conditions and instructional structures that support learners' physical comfort, cognitive functioning, and psychological well-being. Contemporary scholars argue that classrooms designed with ergonomic principles can significantly influence how students engage with learning tasks and process information. Rather than functioning as isolated factors, ergonomic features operate through mediating mechanisms such as physical comfort, environmental quality, and cognitive alignment of instructional design. These mechanisms collectively shape students' learning outcomes, making ergonomics a critical framework for modern educational planning (Liu & Zhou, 2025; Mercugliano et al., 2025)

LITERATURE REVIEW

Students' learning outcomes refer to the knowledge, skills, competencies, attitudes, and academic achievements gained through the learning process. These are often reflected in academic performance, classroom participation, concentration, and the ability to apply learned concepts (Organisation for Economic Co-operation and Development, 2021; Fiveable, 2024). According to Okoi, Okoi, and Eteng (2022), these outcomes are not merely products of individual intelligence but are inextricably tied to the quality of the learning environments. When the classroom is designed to accommodate the user's needs, students exhibit higher levels of engagement and retention. That is, environments that support comfort and cognitive ease enhance motivation and engagement, leading to stronger learning performance (Uyal & Umar, 2022). Conversely, poor classroom conditions can create cognitive distractions, fatigue, and discomfort, which interfere with sustained attention and information processing. Thus, poorly designed space acts as a "silent barrier" to academic achievement. Avedzi et al. (2025) emphasized that learning outcomes are best understood as products of interaction between learners and their environments, reinforcing the importance of ergonomic classroom design in promoting effective education.

Ergonomic classroom design involves planning classroom spaces, furniture, environmental conditions, and learning materials to match learners' physical and psychological needs, promoting comfort, safety, and effective learning (Omotayo et al., 2025; World Health Organization, 2022). This approach extends beyond furniture design and seating orientation (physical ergonomics) to include lighting, ventilation, spatial organization (environmental ergonomic) and material and instructional design (cognitive ergonomics), all of which collectively influence students' posture, movement, and overall classroom experience. Thus, teaching and learning outcomes are optimized only when the educational infrastructures are ergonomically sound, as students cannot achieve peak performance in spaces that compromise their physical and mental health (Bawa and Lawal, 2024). However, the realization of these outcomes begins with the mediating influence of physical ergonomic, which is concerned with the anthropometric fit between students and their classroom furniture.

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Physical ergonomics focuses on the relationship between the human body and classroom furniture, layout, and posture demands. This dimension is critical because prolonged physical discomfort can divert attention away from academic tasks. Contemporary studies emphasized that classroom furniture and spatial layouts in many educational institutions are often designed without adequate ergonomic considerations. This create a mismatch between students' anthropometric characteristics and the physical learning environment (Fidelis, Ogunlade, & Adelakun, 2018; Omotayo et al., 2025). Such mismatches are commonly reflected in inappropriate desk heights, non-adjustable seating, inadequate legroom, and congested seating arrangements, which fail to accommodate variations in students' body dimensions and learning needs. This mismatch leads to "postural overload," causing pain in the neck, back, and shoulders. Moreso, Ismaila, Akanbi, and Oderinu (2015) also noted that when a student is physically uncomfortable, their attention is diverted from the lecture to their bodily distress. This physical discomfort reduces "on-task" time, meaning the student's physical stamina is depleted before the learning objectives are met, directly hindering their overall academic. Ergonomic furniture that supports proper posture has been associated with improved comfort and increased task persistence, suggesting a mediating effect between classroom design and learning outcomes (Liu & Zhou, 2025).

Closely connected to physical ergonomics is environmental ergonomics, which addresses lighting, acoustics, temperature, air quality, and spatial atmosphere. Environmental conditions influence physiological stress levels and cognitive readiness. Sawlani (2025) highlights that factors such as lighting, ventilation, and noise levels have significant direct effects on student performance. This was in line with Okorie and Eze's (2024) study, which revealed that inadequate lighting, poor ventilation, and congested classroom layouts significantly impair students' visual comfort and thermal satisfaction, leading to reduced learning efficiency. The authors argue that when environmental conditions around the classrooms are suboptimal, students expend additional cognitive effort coping with discomfort, thereby limiting the mental resources available for learning tasks. In many Nigerian classrooms, high temperatures and poor ventilation lead to increased carbon dioxide levels, which Oluwaseun (2020) links to drowsiness and diminished cognitive speed. Furthermore, the acoustic environment is vital; if background noise is high, the "speech intelligibility" of the instructor is compromised. This forces the student to exert extra mental effort just to hear, leading to auditory fatigue and a subsequent drop in the quality of learning outcomes.

The bridge between these physical/environmental states and actual knowledge acquisition is cognitive ergonomics, particularly through the lens of instructional design. In the Nigerian educational context, Nwankwo (2021) defines cognitive ergonomics as the alignment of teaching methods with the human brain's information-processing limitations. This involves designing lessons that do not overwhelm the student's working memory, a concept often referred to as managing "cognitive load." Cognitive ergonomics focuses on reducing extraneous cognitive load, structuring information clearly, and designing learning tasks that match learners' developmental levels. Research emphasizes that instructional environments designed with cognitive principles enhance knowledge retention and conceptual understanding (Liu & Zhou, 2025). Flexible learning spaces that support collaboration, movement, and multimodal instruction allow teachers to implement cognitively supportive teaching strategies. When instructional design is synchronized with ergonomic space planning, students experience fewer cognitive barriers and greater engagement (Uyal &

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Umar, 2022). When the cognitive effort required to navigate the learning environment is minimized, students can redirect their mental energy toward deep learning and problem-solving. Thus, cognitive ergonomics acts as a critical mediator by translating ergonomic classroom design into meaningful learning experiences.

Statement of the Problem

Effective learning environments play a crucial role in shaping students' academic performance and overall well-being. However, students often encounter physical discomfort due to poorly designed seating, environmental stressors such as inadequate lighting and high temperatures, and cognitive overwhelm stemming from complex instructional delivery. While traditional views often attribute poor learning outcomes solely to student indolence or lecturer incompetence, there is a growing concern that the classroom's ergonomic deficiencies act as a silent barrier to performance. If the physical, environmental, and cognitive needs of the students are not addressed, the institutional goal of producing high-quality graduates may be compromised by avoidable fatigue, reduced concentration, and physical strain. Though several studies have been conducted on ergonomic classrooms but there is a paucity of research that concurrently investigates how physical, environmental, and cognitive ergonomics converge to shape undergraduate students' learning outcomes within the landscape of The Federal Polytechnic, Ilaro, Ogun. This study, therefore, seeks to fill the gap by empirically examining how these ergonomic dimensions influence student success. In view of this, the study aimed to investigate the influence of these ergonomics factors on students' learning outcomes at Federal Polytechnic, Ilaro, Ogun, and to contribute to the existing body of knowledge.

Objectives of the Study

The primary objective of this study was to examine the influence of ergonomic classrooms on students' learning outcomes at Federal Polytechnic, Ilaro. The specific objectives were to:

i. Evaluate the influence of physical ergonomics (classroom furniture and spatial layout) on students' learning outcomes.

ii. Examine the impact of environmental ergonomics (lighting, ventilation, and noise levels) on students' learning outcomes.

iii. Assess the effect of cognitive ergonomics (mental workload and instructional clarity) on students' learning outcomes.

METHODOLOGY

This study employed a descriptive research design, and the targeted population comprised 6,966 ND II and HND II students of Federal Polytechnic, Ilaro, Ogun State, from which a sample of 346 respondents was selected using Krejuice & Morgan's Sample Size Table. Three hypotheses were formulated, and data collection was facilitated through an online structured questionnaire titled "Ergonomics Classroom and Students' Learning Outcome Scale." The questionnaire was adapted from existing literature, and it contains 15 questions. However, 226 responses were received and used as the sample of the study. The data were

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analyzed using Simple Linear Regression to test the three hypotheses at a significance level of 0.005.

Analyses and Discussion

H_o1: ***There will be no significant influence of physical ergonomics on students' learning outcome at Federal Polytechnic, Ilaro***

Table 1a: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.420[a]	.177	.173	.758	.177	47.885	1	223	.000

a. Predictors: (Constant), Physical Ergonomics

Table 1b: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	27.493	1	27.493	47.885	.000[b]
	Residual	128.036	223	.574		
	Total	155.529	224			

a. Dependent Variable: Students' Learning Outcome
b. Predictors: (Constant), Physical Ergonomics

Table 1c: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.270	.218		10.406	.000
	Physical Ergonomics	.394	.057	.420	6.920	.000

a. Dependent Variable: Students' Learning Outcome

Tables 1a, 1b & 1c present the results of the regression analysis on the influence of physical ergonomics on students' learning outcome at Federal Polytechnic, Ilaro. Table 1a shows the model summary of the relationship between physical ergonomics and students' learning outcome at Federal Polytechnic, Ilaro. The result indicates that there is a moderate positive relationship between physical ergonomics and students' learning outcome with a correlation coefficient of 0.420. The coefficient of determination (adjusted R-squared = 0.173) shows that about 17.3% of the total variation in students' learning outcome could be attributed to physical ergonomics. The variables not examined in this study accounted for the remaining 82.7% of the variation in students' learning outcome. The analysis of variance of the mean of the independent (physical ergonomics) and dependent variable (students' learning outcome) as illustrated in Table 1b shows a p-value of 0.000, which falls below the significance level of 0.05, along with an F-value of 47.885. These results signified a statistically notable distinction between the mean of the variables.

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Table 1c presented the result of the regression co-efficient of the influence of physical ergonomics on students' learning outcome at Federal Polytechnic, Ilaro, which shows that physical ergonomics is a significant predictor of students' learning outcome ($\beta = 0.420$, $t = 6.920$, $p<0.005$). The results also indicated that a unit increase in physical ergonomics will lead to approximately a 39.4% increase in students' learning outcome at Federal Polytechnic, Ilaro. The results also indicated that students' learning outcome is constant at 22.70% without physical ergonomics. Hence, with p-value 0.000<0.05, the null hypothesis, which stated that there will be no significant influence of physical ergonomics on students' learning outcome at Federal Polytechnic, Ilaro, was rejected, and the alternative hypothesis that there will be a significant influence of physical ergonomics on students' learning outcome at Federal Polytechnic, Ilaro, was upheld.

Ho2: There will be no significant influence of environmental ergonomics on students' learning outcome at Federal Polytechnic, Ilaro

Table 2a: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.629[a]	.395	.392	.649	.395	145.706	1	223	.000

a. Predictors: (Constant), Environmental Ergonomics

Table 2b: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	61.462	1	61.462	145.706	.000[b]
	Residual	94.067	223	.422		
	Total	155.529	224			

a. Dependent Variable: Students' Learning Outcome
b. Predictors: (Constant), Environmental Ergonomics

Table 2c: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.769	.169		10.481	.000
	Environmental Ergonomics	.536	.044	.629	12.071	.000

a. Dependent Variable: Students' Learning Outcome

Tables 2a, 2b & 2c present the results of the regression analysis on the influence of environmental ergonomics on students' learning outcome at Federal Polytechnic, Ilaro. The relationship between the variables, as presented in the model summary in Table 2a, revealed a moderate and positive correlation of 0.629 between environmental ergonomics and students' learning outcome at Federal Polytechnic, Ilaro. The results also revealed that the Adjusted R-Square is 0.392, indicating that about 39.2% of the total variation in students' learning outcome could be ascribed to environmental ergonomics. The remaining 60.8% difference could be explained by factors not examined in this study. This is accomplished by a Standard Error of 0.649.

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In the same vein, the result of the analysis of the variance as presented in Table 2b shows that the regression model is statistically significant with p-value = 0.00 which is lesser than 0.05 level of significance. This indicates that environmental ergonomics contributes significantly to the variation in students' learning outcome at Federal Polytechnic, Ilaro. Also, the calculated F value is 145.706. Furthermore, Table 2c presents the mean increase in students' learning outcome in every additional increment in environmental ergonomics. Based on the results, a unit increase in environmental ergonomics will lead to about a 53.6% increase in students' learning outcome at Federal Polytechnic, Ilaro. The results also indicated that students' learning outcome at Federal Polytechnic, Ilaro, will stand at 17.69% without environmental ergonomics. Hence, at t-value 12.071 and p-value 0.000<0.05, the null hypothesis, which claimed that there will be no significant influence of environmental ergonomics on students' learning outcome at Federal Polytechnic, Ilaro, was refuted.

$H_0$3: ***There will be no significant influence of cognitive ergonomics on students' learning outcome at Federal Polytechnic, Ilaro***

Table 3a: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.686[a]	.471	.469	.607	.471	198.611	1	223	.000

a. Predictors: (Constant), Cognitive Ergonomics

Table 3b: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	73.266	1	73.266	198.611	.000[b]
	Residual	82.263	223	.369		
	Total	155.529	224			

a. Dependent Variable: Students' Learning Outcome
b. Predictors: (Constant), Cognitive Ergonomics

Table 3c: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.593	.158		10.111	.000
	Cognitive Ergonomics	.592	.042	.686	14.093	.000

a. Dependent Variable: Students' Learning Outcome

Table 3a shows the model summary of the relationship between cognitive ergonomics and students' learning outcome at Federal Polytechnic, Ilaro. The result indicates that there is a high and positive relationship between cognitive ergonomics and students' learning outcome, with a correlation coefficient of 0.686. The result also revealed an Adjusted R-Square of 0.469. indicating that about 46.9% of the total variation in students' learning outcome could be attributed to cognitive ergonomics. Thus, variables not examined in this study accounted for the remaining 53.1% of the variation in students' learning outcome.

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The analysis of variance of the mean of the independent variable (cognitive ergonomics) and dependent variable (students' learning outcome) as presented in Table 3b indicated a p-value of 0.000, which falls below the significance level of 0.05, along with an F-value of 198.611. These results signified a statistically notable distinction between the mean of the variables.

In addition, Table 3c presents the result of the regression coefficient of the influence of cognitive ergonomics on students' learning outcome at Federal Polytechnic, Ilaro, which shows that cognitive ergonomics is a significant predictor of students' learning outcome with a t-value of 14.093 and a p-value less than 0.005. The results also indicated that a unit increase in cognitive ergonomics will lead to approximately a 59.2% increase in students' learning outcome at Federal Polytechnic, Ilaro. However, the results also indicated that students' learning outcome is constant at 15.93% without cognitive ergonomics. Hence, with a p-value of 0.000<0.05, the null hypothesis, which stated that there will be no significant influence of cognitive ergonomics on students' learning outcome at Federal Polytechnic, Ilaro was rejected and the alternative hypothesis that there will be significant influence of cognitive ergonomics on students' learning.

DISCUSSION OF FINDINGS

The first hypothesis stated that there will be no significant influence of physical ergonomics on students' learning outcome. However, statistical analysis strongly rejects this, confirming that the physical conditions of the learning environments significantly influence academic performance at Federal Polytechnic, Ilaro. This suggests that the quality of the physical setting is a critical factor that cannot be ignored when evaluating educational success. Thus, as the quality of the classroom environment improves, student achievement tends to follow a similar upward trend. While several variables contribute to a student's success, the physical setting (including how comfortable they are and how well the space is designed) accounts for a meaningful portion of the differences observed in their academic results.

Also, the results revealed that every improvement made to the physical ergonomic standards of the lecture halls yielded a positive gain in students' learning outcomes. This highlights the importance of the baseline conditions provided by the institution. When the physical environment is optimized, students are better positioned to reach their full potential, as the predictive nature of the analysis shows that the classroom setting is a foundational component of the overall educational experience. These findings align with established educational and ergonomic theories. As noted by Ismaila et al. (2019), physical discomfort act as a major distraction that pulls a student's focus away from their studies and toward their own physical strain. In the specific context of Nigerian higher education, Fidelis et al (2018) and Omotayo et al. (2025) have pointed out that poorly designed or mismatched classroom furniture often leads to premature fatigue and reduced attention spans. Furthermore, the degree to which student success is attributed to the environment in this study mirrors global research, such as the work of Liu & Zhou (2025), which emphasizes that physical surroundings are a vital, though often overlooked, pillar of the learning process.

The second hypothesis claimed that there is no significant influence of environmental ergonomics on students' learning outcome at Federal Polytechnic, Ilaro, Ogun State. The result of the analysis of the data gathered provide compelling evidence to reject the null

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hypothesis, confirming that environmental ergonomics exert a significant influence on students' learning outcomes at Federal Polytechnic, Ilaro. The extremely low probability value indicates that the relationship between the learning environment and academic success is not a result of random chance but a statistically significant reality. This suggests that the atmosphere in which students are taught is a primary driver of their educational achievement within the institution. The strength of this relationship is characterized by a strong positive correlation, showing that as environmental conditions such as lighting, temperature, and acoustics improve, there is a consistent and notable rise in student performance. This implies that when the environment is optimized, it removes the physiological and cognitive barriers that typically hinder a student's ability to absorb and retain information, leading to a much higher level of predicted academic output. These findings are strongly supported by existing literature regarding indoor environmental quality. Research by Okorie and Eze (2024) emphasizes that poor ventilation and high carbon dioxide levels in classrooms significantly impair memory and concentration. Similarly, Shield and Dockrell (2008) have documented how environmental noise disrupts the communication between lecturers and students, directly lowering learning outcomes.

Hence, the third assumption that there will be no significant influence of cognitive ergonomics on students' learning outcome at Federal Polytechnic, Ilaro, Ogun State, was refuted. The results of the analysis confirmed that cognitive ergonomics exerts a highly significant influence on students' learning outcomes at Federal Polytechnic, Ilaro. The results indicate that the relationship between the mental demands of the learning process and student achievement is not only significant but also the most impactful factor among the variables studied so far. This suggests that how information is processed, the mental workload required, and the clarity of instructional design is fundamental to academic success within the institution. Notably, cognitive ergonomics accounts for nearly half of the total variance in learning outcomes. This high level of explanatory power indicated that the mental ease with which a student can interact with their curriculum is a primary determinant of their success, outweighing the impact of both the physical furniture and the general environment.

The results also revealed that the baseline performance of students is significantly bolstered when the "mental friction" of learning is reduced. By focusing on the way tasks are structured and how information is presented, the institution can achieve the most substantial gains in student outcomes, as the predictive strength of cognitive factors is exceptionally high compared to other ergonomic interventions. These findings are deeply rooted in Cognitive Load Theory, as developed by Sweller (1988), which argues that since the human brain has a limited working memory, instructional materials must be designed to avoid overloading it. In a technical education setting like a polytechnic, where information is often complex, Liu & Zhou (2025) emphasize that cognitive ergonomics, such as the effective use of visual aids and the logical sequencing of information, is essential for student retention. Furthermore, Uyal & Umar (2022) highlights that when the cognitive effort required to navigate the learning environment is minimized, students can redirect their mental energy toward deep learning and problem-solving, a conclusion that is strongly supported by the high degree of influence identified in this study.

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CONCLUSION

From the findings of the study, it is evidence that physical, environmental, and cognitive ergonomics are all critical and statistically significant determinants of students' learning outcomes at Federal Polytechnic, Ilaro, with each factor playing a distinct role in academic success. While physical ergonomics provides the necessary bodily comfort to prevent distraction and environmental ergonomics creates a conducive atmosphere for concentration, cognitive ergonomics emerged as the most influential factor, accounting for nearly half of the variance in student performance. Thus, the study concluded that academic achievement is not solely dependent on student's effort or instruction given in the classroom but also influenced by the holistic design of the learning environment.

RECOMMENDATIONS

Based on the findings, the following recommendations were made:

1. The management of the Institution should ensure that all newly procured classroom furniture meets standardized ergonomic specifications to reduce musculoskeletal strain and physical fatigue among the student body.

2. The management of the Institution should invest in upgrading classroom environmental controls, specifically focusing on improving natural lighting, ventilation, and acoustic insulation to enhance student focus.

3. The institution should prioritize the implementation of cognitive ergonomic strategies by training academic staff in instructional design techniques that minimize unnecessary mental workload for students.

4. The institution should establish a dedicated facility management committee to conduct regular ergonomic audits of lecture halls to identify and rectify environmental and physical stressors promptly.

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