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EFFECT OF CROWDING AND GENDER ON PERFORMANCE IN COGNITIVE TASK AMONG PUPILS

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ABSTRACT

This study examined the effects of classroom crowding and gender on cognitive task performance among primary school pupils in Anambra State, Nigeria. With increasing concerns about overcrowded public classrooms, understanding how environmental stressors and gender differences influence cognitive functioning is critical. A total of 90 pupils (45 males and 45 females) aged 8-10 years participated in the study. The study investigated whether differences exist in cognitive performance across various levels of classroom crowding, between male and female pupils, and whether an interaction effect exists between crowding and gender. Crowd conditions were measured as low (20 pupils), moderate (30 pupils), and high (40 pupils), while cognitive performance was assessed using the Object Assembly subtest of the Wechsler Intelligence Scale for Children (WISC-III). Results from a two-way ANOVA revealed a significant main effect of classroom crowding on cognitive performance with pupils in highly crowded classrooms performing significantly poorly than those in moderate and low crowded classrooms. A significant main effect of gender was also observed indicating that female pupils outperformed males. Additionally, a significant interaction effect was observed suggesting that male pupils were more adversely affected by crowding. These findings highlight the importance of improving classroom conditions and adopting gender-responsive teaching strategies.

***Keywords*:** Anambra, classroom**,** crowding, cognitive performance task, gender, WISC-III.

Introduction

Learning within formal schooling is not merely the delivery of curriculum content; it is a cognitively demanding process requiring sustained attention, memory coordination, perceptual organization, and reasoning. For primary school pupils, these mental operations are still developing and are particularly sensitive to contextual influences. The classroom environment therefore functions not only as a physical setting but also as a psychological space that shapes how cognitive resources are allocated. When environmental conditions are supportive, pupils can devote greater mental energy to processing instructional material. When conditions are strained, cognitive efficiency may decline.

One environmental factor that has drawn increasing scholarly attention is classroom crowding. It is important to distinguish between *density* and *crowding*. Density refers to the numerical concentration of individuals within a given space. However, numerical concentration alone does not inevitably produce discomfort or impaired functioning (Li & Wang, 2026). Crowding emerges when pupils perceive spatial restriction, overstimulation, or limited access to instructional support. Thus, two classrooms with similar numbers of pupils may generate different psychological experiences depending on layout, ventilation, classroom management practices, and teacher responsiveness. Contemporary environmental psychology emphasizes that crowding reflects perceived loss of control and environmental overload rather than simple headcount (Liu et al., 2025).

In Nigeria, overcrowding in public primary schools has become a persistent structural challenge. Rapid population growth, limited infrastructural expansion, and shortages of qualified teachers have resulted in classrooms that frequently exceed recommended pupil–teacher ratios. National reports indicate that many public primary schools operate with class sizes far above policy recommendations, sometimes accommodating 70 to 100 pupils within spaces designed for significantly fewer learners (Ogwo, 2024; Wahab, 2024). Beyond the visible logistical strain, such conditions may carry deeper cognitive implications. When pupils compete for limited teacher attention within stimulating and noisy environments, they may allocate substantial mental effort toward managing distraction rather than engaging fully with learning tasks.

From a cognitive perspective, crowded learning environments may impose additional extraneous demands that compete with working memory resources. Cognitive Load Theory suggests that when environmental stimuli exceed manageable limits, the efficiency of information processing declines (Sweller, 1988). Similarly, environmental stress perspectives propose that sustained exposure to stressors such as noise, limited space, and restricted mobility can impair attentional control and psychological well-being (Evans, 2006; Stokols, 1972). Nigerian-based studies have reported associations between classroom congestion and reduced academic outcomes (Ndubueze & Oboshi, 2021; Salawu et al., 2023), yet relatively few investigations have examined how such environmental conditions influence performance on standardized cognitive tasks that directly measure mental processes underlying learning.

Another dimension that warrants consideration is gender. Although longstanding debates have focused on whether males and females differ in cognitive ability, contemporary scholarship increasingly emphasizes contextual and social influences rather than fixed biological explanations. International evidence suggests that gender differences in certain academic domains often emerge within schooling environments rather than prior to formal education, indicating the potential role of classroom structure and instructional climate in shaping performance patterns. Research conducted between 2023 and 2026 indicates that girls often demonstrate stronger sustained attention and inhibitory control, whereas boys may show heightened sensitivity to environmental stimulation, particularly in structured classroom settings (Giofrè et al., 2024; Kong, 2023). These patterns are not indicative of inherent superiority but may reflect socialization processes and behavioural expectations that influence task engagement.

Despite increasing recognition of crowding as an educational challenge in Nigeria, existing research has primarily concentrated on overall academic achievement. Less attention has been given to the cognitive mechanisms that precede academic performance, such as attention regulation, perceptual organization, and problem-solving efficiency. Furthermore, limited empirical evidence exists regarding whether classroom crowding interacts with gender to influence cognitive functioning among Nigerian primary school pupils. It remains unclear whether boys and girls experience the psychological effects of crowded environments in similar ways or whether one group may be more vulnerable to environmental strain.

Addressing this gap is essential for developing educational policies that recognize both structural and psychological dimensions of learning. By examining standardized cognitive task performance rather than relying solely on academic grades, the present study provides a more direct assessment of how classroom crowding and gender independently and interactively influence the mental processes that support learning. In doing so, it contributes to a deeper understanding of how environmental conditions shape cognitive development within the Nigerian primary school context.

The Statement of Problem in this present study emphasizes that in many Nigerian public primary schools, overcrowded classrooms have become almost normal. In some cases, large numbers of pupils share limited classroom space, compete for teachers' attention, and struggle with noise and distractions. While this situation is often discussed in terms of poor academic results, there is growing concern that the real impact may go deeper, affecting the cognitive processes that support learning. Learning is not only about passing examinations; it depends heavily on attention, memory, and the ability to think and solve problems. When classrooms are overcrowded, pupils may experience increased distraction, reduced individual support, and heightened environmental stress. These conditions may place additional strain on their cognitive capacity. However, despite the visible nature of crowding in many schools, there is limited empirical evidence in Nigeria examining how such conditions influence pupils' performance on standardized cognitive tasks.

At the same time, research suggests that boys and girls may not always respond to classroom conditions in the same way. Some studies indicate that gender differences in attention, behaviour regulation,

and classroom engagement may shape learning experiences. Yet, very few studies within the Nigerian context have examined how classroom crowding and gender work together to influence cognitive task performance. It remains unclear whether overcrowded classrooms affect male and female pupils equally, or whether one group may be more vulnerable to the negative effects of crowding. Without clear evidence on how crowding and gender interact to influence cognitive functioning, educational policies aimed at reducing classroom congestion may fail to address important psychological dimensions of learning. This study therefore seeks to fill this gap by examining the combined effects of classroom crowding and gender on cognitive task performance among primary school pupils.

This study draws upon three complementary theoretical perspectives to explain how classroom crowding and gender may shape cognitive performance. Cognitive Load Theory provides a foundation for understanding how environmental conditions affect working memory efficiency. Rather than viewing learning difficulties solely as a function of instructional content, this perspective highlights the limited capacity of working memory systems. When pupils are required to filter excessive environmental stimuli - including noise, restricted movement, or competition for attention - additional mental effort is diverted away from task-relevant processing ((Ndubueze & Oboshi, 2021; Salawu et al., 2023). In overcrowded classrooms, the accumulation of such extraneous demands may reduce the cognitive resources available for organizing and integrating information, thereby lowering performance efficiency (Sweller, 1988). Over time, repeated exposure to high environmental demand may reduce task persistence and motivation, particularly among pupils who already struggle with attentional control.

Environmental Stress Theory further contextualizes these cognitive processes by emphasizing the psychological consequences of sustained exposure to environmental strain. Chronic stressors, including spatial restriction and overstimulation, may activate physiological and emotional responses that interfere with attention control and executive functioning (Evans, 2006; Stokols, 1972). Within classroom settings, perceived crowding may not only disrupt concentration in the moment but also contribute to cumulative cognitive fatigue. Nigerian evidence suggests that environmental conditions such as noise and limited space are associated with reduced attention functioning among pupils (Nwatah et al., 2022), reinforcing the relevance of this perspective. The mentioned findings align with international evidence by Muñoz et al., (2021) and Ferlazzo et al., (2020), who identified a clear link between environmental stress (like crowding) and reduced cognitive functioning. Studies by Salawu et al. (2023) showed that crowding directly hampers academic achievement, especially in public schools. In primary school children, whose regulatory systems are still developing, such stress responses may manifest as restlessness, withdrawal, or reduced engagement.

Gender Schema Theory offers an additional lens through which to interpret potential differences in how boys and girls respond to crowded learning environments. According to this framework, children internalize societal expectations about gender-appropriate behaviour, which in turn influence academic engagement patterns (Bem, 1981). If girls are socialized to demonstrate compliance and sustained attention

in classroom contexts, they may be better positioned to maintain cognitive focus even under constrained conditions. For example, girls who are socially encouraged to remain attentive despite discomfort may maintain performance under crowded conditions. Boys who are more sensitive to overstimulation may exhibit larger performance declines when environmental demands escalate. Importantly, such patterns reflect contextual dynamics rather than intrinsic intellectual differences. Conversely, if boys are more responsive to environmental stimulation, crowded settings may amplify attention distraction. Recent empirical findings indicate that while overall intelligence does not differ significantly between genders, variations may emerge in attention regulation and spatial processing tasks (Giofrè et al., 2024; Kong, 2023). These context-dependent patterns underscore the importance of examining interaction effects rather than isolated main effects. In Nigeria, Kabir and Adedamola (2023) found that female pupils scored higher in attention-related tasks than their male peers under the same classroom conditions.

Together, these frameworks suggest that classroom crowding may reduce cognitive performance by increasing extraneous cognitive load and environmental stress, while gender-related behavioural patterns may moderate the magnitude of this effect. Integrating these perspectives provides a comprehensive explanation for both independent and interactive influences on pupils' cognitive functioning.

However, the present study seeks to examine the effects of classroom crowding and gender on cognitive task performance among primary school pupils. Specifically, the study addresses the following research questions: what is the effect of classroom crowding on pupils' cognitive task performance? Are there differences between male and female pupils in cognitive task performance? Does classroom crowding interacts with gender to influence pupils' cognitive task performance? In line with these questions, the study test the hypotheses that there will be no significant difference in cognitive performance across varying levels of classroom crowding; no significant difference between male and female pupils in cognitive task performance; and that there will be no significant interaction effect between classroom crowding and gender on cognitive performance. By addressing these questions, the study contributes to a deeper psychological understanding of how environmental and demographic factors shape learning outcomes in Nigerian primary schools.

Understanding how classroom crowding influences cognitive task performance carries practical and policy relevance. Educational reforms often prioritize enrollment expansion, curriculum revision, and teacher training. While these initiatives are essential, insufficient attention to environmental learning conditions may undermine their effectiveness. If pupils are cognitively strained by overcrowded settings, improvements in curriculum quality alone may not yield optimal outcomes. For policymakers, evidence linking crowding to cognitive performance strengthens arguments for infrastructural investment. Reducing classroom congestion is not merely a logistical improvement; it is a psychological intervention that may enhance attention functioning and learning efficiency. For school administrators, findings regarding interaction effects may inform classroom management strategies that account for diverse behavioural needs.

For researchers, the study contributes to a growing body of literature that situates cognitive functioning within ecological contexts. By focusing on Nigerian primary school pupils, the research adds context-specific evidence to international discussions on classroom environment and learning.

Hypotheses

1. Classroom crowding will not have a statistically significant effect on the cognitive performance among pupils.
2. There will be no statistically significant difference between male and female pupils cognitive task performance.
3. There will be no statistically significant interaction effect between classroom crowding and gender on cognitive task performance among pupils.

Methods

Participants

The participants consisted of ninety (90) primary school pupils (45 males and 45 females) drawn from primary 4 at Nnewichi Central School, Nnewi. Their ages ranged from 8 to 10 years (M = 9 years). They were from Igbo ethnic group. Participants were selected using a stratified sampling technique to ensure equal representation of male and female across the three classroom conditions. This approach reduced gender imbalance while maintaining variation in academic ability within the sample. Participants were randomly assigned (through balloting) into three crowding conditions: Low crowding - 20 pupils (10 males, 10 females); Moderate crowding - 30 pupils (15 males and 15 females); and High crowding - 40 pupils (20 males and 20 females).

Instrument

The instrument used in collecting data was Object Assembly test developed by Weschler (1991). It is a cognitive performance subtest of Weschler Intelligent Scale for Children – Third Edition (WISC-III). It contains 5 items that measures perceptual organization, visual-spatial reasoning, and problem solving ability. The WISC-III has established construct and content validity based on extensive standardization procedures. For the present study, face validity was confirmed by two experts in educational psychology who reviewed the instrument for suitability within the Nigerian classroom context. A pilot study involving 30 pupils was conducted to assess clarity of instructions and administration procedures. Test-retest reliability over a 24-hour interval yielded a reliability coefficient of r = .73, indicating acceptable stability. The test was scored by awarding 3 marks each to every correctly fitted object of man, girl, house, and horse. While 2 marks each was to every correctly object of car. To be specific,

Man 9 pieces 3 marks each =27 marks

Girl 7 pieces 3 marks each = 21 marks

House 6 pieces 3 marks each = 18 marks

Horse 6 pieces 3 marks each =18 marks

Car 8 pieces 2 marks each = 16 marks

Total 100 marks

Procedure

The researchers first obtained ethical approval from the school authority. Permission was granted by the headmistress, and informed consent was obtained from parents through the school administration. Pupils were assured that participation was voluntary and that their responses would remain confidential

The experiment was carried out during morning hours. It started at 9:00am and ended at 11:00am. The period fixed for experiment was such that the selected pupils were free from pressing school activities. The groups were put in different classrooms. Each classroom was measured 16ftx20ft. A classroom with 40 pupils was categorized as highly crowded, 30 pupils as moderately crowded, and 20 pupils as low crowded. Before the instrument was distributed, the researchers had to make sure that the classrooms were well arranged, lighted, and noiseless. Research assistants helped in keeping away other pupils from approaching the place of experiment. After establishing rapport, the instrument was administered to the three groups on sheets of paper, and they were given instructions on how to go about completing it. Thirty (30) minutes later, the instrument was collected from them. The researcher rendered her thanks to everyone that participated in the experiment and to their headmistress. The responses of the participants were scored and analyzed.

Although intelligence level was not directly controlled prior to the experiment, the use of pupils within a similar age range and educational level helped to minimize extreme variations. Furthermore, the cognitive task instrument used (Object Assembly subtest of WISC III) inherently reflects cognitive functioning, thereby partially accounting for individual differences in intellectual ability.

Design/Statistics

This study adopted a quasi-experimental design to examine the effects of gender (male, female) and classroom crowding (low, moderate, high) on cognitive performance. This design was appropriate because it enabled the researchers to examine both the main effects and interaction effects of the independent variables on cognitive task outcomes. The data analysis was conducted using SPSS (Statistical Package for the Social Sciences) version 25. A two-way Analysis of Variance (ANOVA) was conducted to test the hypotheses at the .05 level of significance.

Results

Table 1: Group Mean (M) and Standard Deviation (SD) scores on cognitive performance

Crowding	N	Mean (M)	Standard Deviation (SD)
Low	20	82.1	7.5
Moderate	30	75.4	8.6
High	40	69.3	9.2
Male	45	71.8	8.4
Female	45	78.1	9.6
Total	90		

Table 1 indicates that high crowded group obtained lower score on object assembly ($\overline{X}$=69.3, SD=9.2) than the moderate crowded ($\overline{X}$=75.4, SD=8.6) and low crowded ($\overline{X}$=82.1, SD=7.5) groups. On the other hand, the moderate crowded group obtained lower scores on object assembly ($\overline{X}$=75.4, SD=8.6) than the low crowded group. The table further shows that the females performed higher than the males on object assembly: females have higher mean score ($\overline{X}$=78.1, SD=9.6) than the males ($\overline{X}$=71.8, SD=8.4). The standard deviation of all the groups does not show very wide dispersion in the scores of the pupils on the object assembly. It means that the pupils showed same level of consistency in their scores on object assembly. ANOVA was further used in analyzing the data to determine if the observed differences in mean scores were significant.

Table 2: ANOVA table showing Effect of Crowding and Gender on cognitive Performance

Source	Sum of Squares	df	Mean Square	F	Sig. Partial	η²
Crowding	2438.45	2	1219.23	14.52	< .001	.25
Gender	498.22	1	498.22	5.93	017	.07
Crowding x Gender	642-84	2	321.42	3.83	.026	.08
Error	7154.32	84	85.17			
Total	**10733.83**	**89**				

The result in table 2 shows that the main effect of classroom crowding was significant, f (2, 84) = 14.52, p< .001, η^2= .25, indicating a large effect size. This suggests that classroom crowding accounted for

approximately 25% of the variance in cognitive performance. A significant main effect of gender was also observed, f (1, 84) = 5.93, p = .017, η^2= .07, reflecting a moderate effect. Furthermore, the interaction between crowding and gender was significant, f (2, 84) = 3.83, p = .026, η^2= .08, indicating moderate interaction effect.

Discussion

The present study examined the effects of crowding and gender on cognitive task performance among primary school pupils. The findings revealed three important results: first, crowding had a significant effect on cognitive performance; second, gender significantly influenced cognitive task outcomes; and third, there was a significant interaction between crowding and gender, suggesting that the impact of crowding differed for male and female pupils. The significant main effect of crowding indicates that pupils in highly crowded classrooms performed significantly poorer on cognitive tasks compared to those in moderate and less crowded classrooms. This finding suggests that crowded classroom environments may impose additional cognitive demands on pupils, thereby limiting their ability to concentrate, process information efficiently, and complete problem-solving tasks effectively. In practical terms, when pupils are surrounded by excessive noise, limited movement space, and reduced teacher attention, their mental energy may be diverted toward managing environmental distractions rather than focusing on the task itself.

However, this finding aligns with recent research highlighting the psychological impact of classroom environments on cognitive engagement. For instance, Abubakar et al. (2022) and Ndubueze & Oboshi (2021) reported that overcrowded classrooms negatively affect students' concentration, participation, and academic success. Studies examining classroom design and environmental quality have shown that physical classroom conditions can influence attention regulation, stress levels, and task persistence (Nimityongskul, 2025; Miri et al., 2025; & Siddique et al., 2024). Although some studies distinguish between physical density and perceived crowding, contemporary research emphasizes that when environmental conditions are overwhelming, cognitive efficiency declines. The present finding is also consistent with reports from Nigerian public schools indicating that high pupil-teacher ratios limit individualized instruction and increase classroom noise, which may compromise pupils' engagement and performance. From a theoretical perspective, this result strongly supports Cognitive Load Theory. According to this theory, working memory has limited capacity, and excessive extraneous stimuli such as crowding, distraction, and competition for attention-consume cognitive resources needed for learning tasks. In crowded classrooms, pupils may expend additional mental effort filtering irrelevant stimuli, leaving fewer cognitive resources available for processing task-relevant information. Thus, lower performance in highly crowded classrooms may reflect cognitive overload rather than reduced ability. The findings also support Environmental Stress Theory, which posits that chronic exposure to environmental stressors such as crowding can impair psychological functioning. When pupils perceive their environment as crowded or chaotic, stress responses may interfere

with attention and memory processes. Over time, such environmental strain can undermine cognitive performance and academic confidence.

The second major finding revealed a significant gender difference in cognitive task performance, with female pupils outperforming male pupils. This result suggests that gender may play a role in how pupils engage with structured cognitive tasks, particularly those requiring sustained attention and organization. Recent international research increasingly indicates that observed gender differences in performance are shaped more by contextual and instructional factors than by innate cognitive disparities. Studies conducted between 2023 and 2026 show that gender gaps in certain academic domains often emerge within school contexts rather than before formal schooling begins, suggesting that classroom dynamics and expectations influence performance patterns. The present finding may reflect differences in classroom behaviour regulation and attention control. Some contemporary studies suggest that girls often demonstrate stronger sustained attention and classroom compliance, which may translate into better performance on structured cognitive tasks. However, it is important to interpret this finding cautiously. The difference observed does not imply superiority of one gender over another; rather, it highlights how socialization patterns and classroom expectations may shape task engagement. This result aligns with Gender Schema Theory, which proposes that children internalize societal expectations about gender roles that influence their attitudes, behaviours, and academic engagement. If girls are socialized to be more attentive and compliant within classroom settings, they may be better positioned to perform well on tasks that require concentration and structured problem-solving.

Perhaps the most significant finding of this study is the interaction effect between classroom crowding and gender. The results indicated that the negative impact of crowding was more pronounced for male pupils. This suggests that overcrowded classroom conditions do not affect all pupils equally. Male pupils may be more sensitive to environmental stimulation, distraction, or reduced personal space, which could amplify the cognitive strain associated with crowded conditions. This interaction finding strengthens both Cognitive Load Theory and Environmental Stress Theory by demonstrating that environmental stressors may have differential psychological impacts depending on individual characteristics. It also reinforces recent scholarship emphasizing that gender differences in performance are context-dependent rather than fixed.

Altogether, these findings highlight the importance of considering both environmental and demographic factors in understanding cognitive task performance. In the Nigerian context, where classroom congestion remains a structural challenge, these results underscore the need for policy interventions aimed at reducing overcrowding and improving classroom management practices. Efforts to expand classroom infrastructure and recruit additional teachers may not only improve academic scores but also enhance the cognitive conditions necessary for effective learning for example reduced noise. Moreover, the interaction between crowding and gender suggests that educational reforms should incorporate gender-sensitive

strategies. Teachers may need to adopt differentiated engagement techniques that support both male and female pupils in crowded environments. Interventions that promote attention regulation and classroom organization may help mitigate the cognitive strain associated with high-density learning spaces.

Implications

The findings of this study have important implications for educational practice, policy, and research:

1. *Educational Policy:* The significant effect of classroom crowding on cognitive task performance is evidence that overcrowded classrooms are psychological barriers to effective learning. Thereby, potentiating the need for policymakers to prioritize reduction in class size.
2. *Cognitive Functioning:* Since classroom crowding negatively affects attention, memory, and problem-solving abilities, improving classroom conditions will enhance pupils' cognitive efficiency and overall learning outcomes.
3. *Classroom Management***:** Teachers need to adopt effective classroom management techniques that reduce distractions and improve engagement, especially in crowded classrooms.
4. *Gender-Sensitive Instructions***:** The observed gender differences in cognitive task performance indicate that male and female pupils may respond differently to the classroom environment. This calls for gender-responsive teaching strategies (e.g., use of inclusive language, appropriate seat positioning) to support diverse learning needs.
5. *Research Implication*: The study contributes to environmental and educational psychology research by showing that learning outcomes are influenced by both environmental and demographic factors.

Conclusion and Recommendations

This study concludes that both crowding and gender play critical roles in shaping pupils' cognitive task performance. Crowded classrooms may compromise optimal cognitive functioning by increasing environmental demands on pupils' attention and memory systems. Additionally, female pupils tend to show stronger cognitive performance, and male pupils seem more susceptible to the adverse effects of crowding. Hence, findings highlight the need to address not only structural issues such as class size but also to consider gender-responsive strategies in classroom management and instructional delivery.

With crowded classrooms, pupils try to cope with noise, limited space, and reduced teacher attention, which can drain the mental energy needed for concentration and problem-solving. Recent research supports the idea that classroom design and environmental quality directly shape children's stress levels, attention, and engagement. Overall, the study highlights that crowding is more than a space problem, it is a psychological issue that can affect how well children learn. It also shows the importance of understanding how environmental factors and gender interact to shape pupils' academic experiences.

From a policy standpoint, these results carry significant implications. These findings emphasize the urgent necessity for educational reforms in Nigeria to mitigate classroom overcrowding, especially in public primary schools. Reducing class size may not only improve academic outcomes but also enhance attention, memory, and problem-solving abilities, which are critical for lifelong learning. Reports from the Universal Basic Education Commission (UBEC, 2024) written by Adeodun and Wahab on national dailies indicate substantial shortages in classroom infrastructure and qualified teachers in Nigeria. When classrooms exceed recommended pupil–teacher ratios, the cognitive cost to pupils may be substantial. Educational reforms that prioritize reducing classroom density are therefore not merely infrastructural improvements but psychological interventions that can enhance cognitive functioning and learning outcomes. Policymakers should consider enforcing manageable class-size standards, expanding school infrastructure, and recruiting additional teachers to alleviate congestion. Beyond structural reforms, teachers can adopt practical classroom management strategies that reduce perceived crowding, even where physical expansion is not immediately feasible. Organizing seating arrangements strategically, promoting structured routines, and implementing attention-regulation techniques may help mitigate environmental strain. Gender-responsive teaching approaches may also be beneficial, particularly in supporting pupils who may be more sensitive to environmental distractions. Furthermore, gender-sensitive interventions should be incorporated. For instance, providing differentiated instructional strategies and teacher training could help mitigate the disproportionate effects of crowding on male pupils.

While this study contributes valuable insights, its limitations must be acknowledged, and findings should be interpreted with caution. The study did control for general intelligence levels among participants and had no control group. Although efforts were made to ensure relative homogeneity in age and educational background, variations in intellectual ability may have influenced performance outcomes. Future studies should incorporate standardized intelligence screening to control for this variable more rigorously. The sample size was limited to 90 pupils drawn from a single school in Anambra State, which may limit generalizability to other regions in Nigeria. Future studies should include larger and more diverse samples across different geopolitical zones. Moreover, longitudinal designs could examine how long-term exposure to crowding affects cognitive development over time. Furthermore, future studies should explore mediating variables such as teacher quality, classroom management style, and pupils' socioeconomic background. Qualitative approaches may also provide deeper insight into pupils' subjective experiences of crowding, complementing quantitative findings. Given the growing international emphasis on inclusive and psychologically supportive learning environments (UNESCO, 2023), further investigation into environmental–gender interactions would contribute meaningfully to educational policy and psychological science.

The authors declare no conflict of interest and affirm that this research was conducted in accordance with accepted ethical and academic research standards.

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