NIPES - Journal of Science and Technology Research
www.nipes.org

Understanding Sustainable Architectural Design Principles and Students' Well-Being

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Abstract*— The built environment contributes to the overall well-being of humans, and evidence also shows that the built environment and students' well-being are related. Many secondary schools in Nigeria lack adequate facilities, including well-maintained buildings, classrooms, playgrounds, libraries, laboratories, and other essential educational equipment. Little is known about the effects of school design on students' well-being in the country. Therefore, this study focused on applying sustainable design principles at Obele Community Senior High School to enhance student well-being and achieve the national education goals and the Sustainable Development Goals (SDGs). The survey research design was employed, and the respondents were selected using a three-stage sampling technique. A structured questionnaire was used to gather information from the 215 respondents for this study. The data were analysed with descriptive and inferential statistics. The results show that more than average (53%) of the students agreed that the school design meets the sustainable school design principles. About 27% of the students showed that the school design meets their well-being. Furthermore, the sex of the students, class size, and sustainable design were found to impact students' well-being. This study underscores the importance of school design on students' well-being. Thus, this study recommends the renovation of the school by the stakeholders in collaboration with architects. While doing so, consideration should be given to the need of girls and boys in the school. Also, the Ministry of Education should work hand in hand with architects before embarking on the renovation and construction of schools in the future.

***Keywords*—Sustainable architectural design, public secondary school, students, well-being**
https://doi.org/10.37933/nipes/7.4.2025.SI9
eISSN-2682-5821| pISSN-2734-2352

I. INTRODUCTION

The United Nations' Sustainable Development Goals (SDGs) of 2015, specifically Goals 3, 4, and 11, emphasize good health, quality education, and sustainable communities are essential for fostering equitable societies. Research confirms that the built environment's influence on well-being, with school design, is linked to both students' physical and mental health outcomes [1]. For instance, inadequate facilities, such as those found in Nigerian schools, can exacerbate student stress and limit academic performance [2,3].

Mental health statistics reveal that 13% of adolescents in high school had a major depressive episode in 2020, according to the National Institute of Mental Health, while a WHO report indicates that 10-20% of children experience mental health disorders. Physical activity also correlates with mental health, yet 81% of adolescents globally fail to meet recommended activity levels. Additionally, a sense of belonging is critical to student well-being, yet 20% of students across OECD countries report feeling disconnected at school [4]. Socioeconomic factors further worsen these issues, particularly in Nigeria and South Africa, where educational disparities and limited access to mental health resources are prominent [5].

The quality of school facilities is pivotal for effective learning. Research by [6] highlights three key environmental characteristics for optimal learning: natural light, stimulating design elements, and flexible spaces. Studies show that uncomfortable environments, such as poorly ventilated or overcrowded classrooms, impede learning. For effective teaching, environments should support teachers' needs and be free of distractions, such as noise and pollution, which can reduce student concentration [7]. An organized and conducive learning space is necessary for academic success, but reports show that many schools globally lack such environments with basic furniture and have limited outdoor or green spaces [8-9].

In Africa, limited access to safe, hygienic, and engaging learning environments hinders educational progress. In Nigeria, for example, fewer than two in ten schools meet basic hygiene standards; 25% have limited drinking water, and only 38% have adequate sanitation [10]. School infrastructure deficits also extend to the availability of green spaces, which studies show are vital for mental well-being. For Nigerian students, whose reported well-being stands at just 44.6% [11], these deficits signal an urgent need for educational reform.

Architectural school design has been recognized as a crucial factor influencing students' well-being, academic performance, and overall educational experience [12]. Ensuring supportive, sustainable school environments is essential for achieving the SDGs related to education, health, and community sustainability. Enhanced investment in educational infrastructure and sustainable design can provide the necessary foundation for improved student well-being and academic performance globally. Therefore, this study focused on the impact of sustainable architectural design on the well-being of students at Obele Community High School, Ojuelegba, Lagos State, Nigeria.

II. LITERATURE REVIEW

Concept of Sustainable Architecture

In architecture, sustainable architecture is an applied concept that seeks to advance the "concept of sustainability," or the idea of preserving natural resources for future generations. Human survival depends on natural resources and the human ecological environment, which includes the forestry sector, agricultural systems, climate system, and, of course, architecture. The concept of "sustainable architecture" seeks to improve the health of both people and animals by reducing the negative environmental consequences that buildings produce. Green architecture is another name for sustainable architecture, according to [13]. As [14] points out, sustainable architecture is an effort to combine the economy and ecology into a single system. Additionally, it talks about how architects apply eco-friendly design concepts in their work. Through efficiency and moderation, as well as the optimization of material, energy, and development area consumption, sustainable design seeks to lessen the negative environmental effects of buildings.

Furthermore, the foundation of sustainable architecture is the promotion of human-nature connections and environmental concerns. The environmental effects of a building's lifecycle, construction, and manufacturing processes are also reduced by the design of sustainable buildings, often referred to as sustainable architecture. This design strategy prioritizes the efficiency of heating and cooling systems. Additionally, [15] proposed that sustainable architecture is an approach that integrates various concerns, including design, materials, energy use, cost, and the environment, to create a useful structure that meets current needs without jeopardizing the ability of future generations to meet their own resource needs. By enhancing efficiency and utilizing resources, energy, development space, and the ecosystem in moderation, this design aims to minimize the negative environmental impacts of buildings. Additionally, it employs a purposeful approach to energy and environmental conservation in shaping the built environment.

According to [16] and [17], sustainable architecture is a modern trend in architectural design that aims to balance the environment by using improved abilities. Sustainable architecture, also known as green design, is one construction technique that reduces adverse effects on the environment and human health. An architect or designer also aims to preserve the air, water, and land by choosing an environmentally suitable building. More efficient use of the architect's abilities is thought to be a contemporary method of architectural design that seeks to attain balance with the natural world. When architects are conversant with green buildings, they may introduce ideas that take the environment's long-term consequences into account, teaching them the best ways to interact with nature. This study employed some of the design principles and the design of the school on how it affects Obele High School students' well-being.

Concept of Well-being

Well-being is a complex and multifaceted concept that has been studied and defined in various ways by researchers over the years. At its core, well-being encompasses an individual's overall quality of life, life satisfaction, and happiness [18]. Physical well-being is a critical aspect of overall well-being, and the [11] defines it as physical health and functioning, including nutrition, exercise, sleep, and disease prevention. Emotional well-being, on the other hand, refers to an individual's emotional state, including their ability to recognize and manage emotions, overall mood, and life satisfaction [19]. Also, [19] proposes that overall well-being consists of five core elements: Positive

emotions, engagement, relationships, meaning, and accomplishment. Social well-being is another critical dimension of well-being, and [20] defines it as social connections, social support, and a sense of community membership.

Empirical Literature Review

The design of schools profoundly impacts students' well-being. Research consistently shows that schools with well-designed learning spaces, which incorporate natural Research efforts have shown that green spaces on campus and students' well-being are positively related. [22-28].

Scholars have also reported that good learning space not only enhances students' academic performance but also have a positive influence on students' well-being [29-31], academic performance [32], and reduces misbehavior rates and absenteeism due to illness [33].

Researchers have also delved into the studies on the association between class size and students' well-being. They all found that an indirect relationship exists between class size and students' well-being [34-39].

Studies have shown that girls tend to report higher levels of emotional distress, anxiety, and depression than boys [40]. Also, research suggests that while boys are more likely to engage in bullying behavior, girls are more likely to be victims of bullying and social exclusion [41-42].

The significance of architectural design in influencing student outcomes is reinforced by existing research. [43] elements and minimize noise pollution, can enhance students' cognitive, behavioral, and physical well-being. [21] investigated how high school architectural design affected Egyptian users' well-being. The study made use of primary data gathered from 430 students via surveys, questionnaires, and observation. Descriptive statistics were used to analyze the data, and the results indicate that the school did well in the functional area, poorly in the behavioral area, and not at all in the aesthetic area.

A study of 153 classrooms revealed that physical design elements, such as lighting, air quality, and layout, explained 16% of the variation in primary school students' learning progress over a year. Similarly, [44] highlighted the importance of well-designed school spaces, emphasizing the role of ventilation and natural light in promoting improved student outcomes.

It is evident from the literature reviewed that evidences abound that school architectural design, class size, and the sex of students are significantly related across the nations of the world. However, as far as we know, little is known about the association between school building design and students' well-being. Hence, this study attempted to fill the research gap by examining the relationship between sustainable architectural design and students' well-being: A case of Obele High School, Ojuelegba in Lagos State, Nigeria.

The definition and *a priori* expectations and definition of the variables used in the probit model are presented in Table 1.

TABLE 1: The definition and *a priori* expectations and definition of the variables used in the probit model

VARIABLE	OPERATIONALIZATION	A PRIOR EXPECTATION	REFERENCES
Sex	1 if male, 0 if otherwise (dummy variable)	+/-	[47, 54]
Age	Number of years (continuous variable)	+/-	[55-56]
Number in class	Number of students (continuous variable)	+/-	[46-47]
Father's education	Continuous variable	+/-	[50, 57]
Mother's education	Continuous variable	+/-	[49]
Father's employment status	Dummy variable	+/-	[58-59]
Mother's employment status	Dummy variable	+/-	[60-61]
Architectural Design	Dummy variable	+/-	[62]

III. METHODOLOGY

The study was conducted at Obele Community Senior High School, a co-educational government-funded high school with 814 students. A three-stage sampling technique was used to select representative students. Stage one involved a purposive selection of SSS II and SSS III students. Stage two stratifies classes into Science, Art, and Commercial fields, yielding eight strata. Stage three involved a random selection of 50% of students from each stratum. Data collection was done with a Geographic Information System (GIS), observation methods, and a well-structured questionnaire between June and July 2024. The questionnaire is made up of three sections, which are:

Section A: This was used to collect information on students' demographic and socioeconomic characteristics such as sex, age, birth order, field of study, parents' educational background, and household size, among others.

Section B contains questions on the architectural design of the school. It has 15 items on a 5-point Likert-type scale (which ranges from 1- strongly disagree to 5 – strongly agree)

Section C: This captures data on students' well-being. The being indicator, which happened to be one of the seven well-being indicators developed by [45], and modified, was used. The indicator consists of four items on a 5-point Likert-type scale (which ranges from 1-strongly disagree to 5 – strongly agree).

The data were analysed with descriptive and inferential statistics. While the mean, standard deviation, frequency, percentages, and graphs were employed to describe the data, the probit model was the inferential statistics used. The data were analysed with STATA 14.

IV. RESULTS AND DISCUSSION

Demographic Characteristics of the Respondents

The results of the demographic characteristics of the students are presented in Table 2. As presented in the table, about 62% are males, and their mean age stood at 16.44 years. With the 6-3-3-4 system of education in the country, the expected average age of graduation from secondary school is 16 years. The mean class size was 45 students. The class size is expected to influence the level of students' well-being [46-47]. However, this is higher than the 35 and 40 recommended by UNESCO and the National Policy on Education, respectively. The findings align with the submission by [48]. Also, about 92% and 90% of the fathers and mothers of the students had above a primary school level of education. Also, while about 86% of the fathers were employed, about 80% of mothers were employed. Parents' level of education and employment status could influence students' well-being [49-50].

Table 2: Description of the Demographic Characteristics of the Respondents

Variable	Mean	Std. dev.	Percentage
Sex (male)	-	-	61.57
Age	16.4419	1.3586	-
Number in class	44.6605	10.4997	-
Father education	-	-	91.63
Mother education	-	-	90.23
Father employment	-	-	86.05
Mother employment	-	-	80.47
Number of observations	215		

Description of students' responses on Sustainable School Architectural Design

The responses of the students to each of the sustainable architectural designs were ranked using the mean, while the weighted mean (3.08) was used to classify them into three categories: very low (<2.5), low (2.5-3.08), and moderately low (>3.08). Table 3 shows the sustainable architectural design status of the school as indicated by the students, which was corroborated by the researchers' observations as well as the results of the GIS. As depicted in the table, the school's architectural design failed to meet the sustainability principle with a weighted mean score of 3.08 out of 5. Likewise, eight of the 15 sustainable architectural design principles are classified as moderately low. Five of the principles are classified as low, and the remaining 2 are classified as very low sustainable design status.

The ranking of each of the sustainable principles shows that the colours of the paints at school are the closest to the sustainable design. This is closely followed by the size of the schoolyard and thermal comfort when the windows are open. The least sustainable design principle

is the availability of an interrupted portable water supply. The school's architectural design plays a major role in determining the well-being of the students.

Table 3: Responses of Students to Sustainable Architectural Design

Item	Mean	Rank	Sustainable Architectural Design status
Students are not overcrowded in the classroom	3.28	8th	Moderately low
The classrooms are well-ventilated	3.51	4th	Moderately low
The classrooms are well-lighted naturally	3.33	6th	Moderately low
The school has a well-equipped library	2.98	10th	Low
The school has a well-equipped ICT centre	2.94	11th	Low
The school has a well-equipped Laboratory	2.83	12th	Low
The roof in my classroom is good	3.25	9th	Moderately low
My school has adequate sports facilities	2.34	5th	Very low
My school possesses green spaces/ecosystem environment	2.65	13th	Low
There are functional conveniences (toilets) for boys and girls	3.33	6th	Moderately low
The schoolyard can accommodate all the students during break or when doing morning activities?	3.52	2nd	Moderately low
I feel thermal comfort in the classroom if the windows are open	3.55	3rd	Moderately low
The school contains aesthetic elements (trees and seating areas etc)	2.46	14th	Very low
I like the colours of the paints at school	3.62	1st	Moderately low
My school has potable/drinkable water that is available uninterrupted	2.53	15th	Low

Description of respondents' well-being

The mean of each of the items on the well-being variable was used to rank the respondents. As shown in Table 4, the weighted mean (3.62) of the responses of the students to their perceived well-being items was classified into two categories: satisfactory and unsatisfactory. With 50% of the items being rated satisfactory, the well-being of the students could be considered moderate. Likewise, the well-being items were ranked using their mean, with opportunities to assume esteemed roles ranking first and the opportunities to be self-independent ranking 4th. While opportunities for ideas and actions ranked 2nd, their physical and mental fitness ranked 3rd.

Table 4: Description of Respondents' Well-being

Item	Mean	Rank	Well-being status
There are opportunities to assume valued and/or esteemed roles in the school	3.94	1st	Satisfactory
Encouragement of self-ownership and responsibility for ideas and actions	3.80	2nd	Satisfactory
Opportunities for **students** to act autonomously under supportive, but reasonably hands-off supervision	3.09	4th	Unsatisfactory
Student is physically healthy, nourished, rested and fit	3.60	3rd	Unsatisfactory

Effects of Sustainable Architectural Design on Students' Well-being

The coefficient and marginal effects of the sustainable building design and other variables were measured and reported in Table 5. The significant chi-square value shows that the model has a good fit to the data. The R-squared value of 0.4058 implied that about 40.58% variation in student well-being was explained by the school design and other variables, while the remaining unexplained variation was due to error terms. Three of the eight variables included in the model (sex, class size, and building design) significantly impacted students' well-being.

The sex of the students negatively and significantly influenced the well-being of students at a 5% significance level. The estimated marginal effect indicated that the likelihood of female well-being is 4.92% lower than that of

their male counterparts. This means that female students had a lower level of well-being than males. This could be because of the non-availability of some gender based infrastructural facilities in the school. The finding is in sharp contrast to that of [51], which reported a higher level of well-being among male students.

The number of students in the class was also a factor that was considered as one of the determining factors. The number of students negatively and significantly influenced the well-being of students at a 1% significance level. The marginal effects show that a one-unit change in the number of students in the class/class size will lead to a 0.28% reduction in the well-being of the students. This could be due to the expansion of the threshold as indicated in the descriptive statistics on the higher number in the class compared to the recommended. This result corroborates the submission of [52, 38, 39]. They all showed that an increase in class size above the threshold is detrimental to students' well-being.

Not surprisingly, a direct and significant relationship exists between the sustainable school design and students' well-being at a 1% significant level. As the marginal effect value shows, the well-being of students in a sustainable school design tends to be higher than those in an unsustainable design by 34.08%. This could be that the students in the classroom and/or with the sustainable design principles were well-off than their counterparts that lacked such privilege. The positive effect of sustainable architectural design agrees with the growing research on the built environment and the role it plays in the education and well-being of students [43, 53].

Table 5: Effect of Sustainable Architectural Design on Students Well-being

Variable	Coefficient	Robust standard error	P>|z|	Marginal effect (dy/dx)
Sex	-0.1241	0.0599	0.048	-0.0492**
Age	0.2068	0.1909	0.279	0.0815
Number in class	-0.0071	0.0015	0.000	-0.0028***
Father education	0.0129	0.0330	0.697	0.0051
Mother education	0.0300	0.0308	0.331	0.0119
Father employment	0.1045	0.2982	0.726	0.0414
Mother employment	0.0803	0.2640	0.761	0.0319
Architectural design	0.8837	0.1951	0.000	0.3408***
Constant	0.9937	1.3124	0.098	
Model diagnostics:				
Log-likelihood	-132.50			
$Prob > Chi^2$	57			
$Pseudo\ R^2$	0.0001			
Number of observation	0.4058			
	215			

Note: ** and *** means 5% and 1% significant levels, respectively; female, not employed and no sustainable architectural design are the reference category respectively for sex, mother employment and father employment as well as architectural school design variables respectively.

V. CONCLUSION

This study focused on the association between sustainable architectural design and the well-being of students of Obele Community High School, Lagos. The study shows a positive association between sustainable architectural design and students' well-being. To improve the well-being of the students, it is recommended that stakeholders in the education sector embark on the renovation/reconstruction of the school. Also, it is suggested that the Ministry of Education should work hand in hand with architects before embarking on school renovation and construction in the future.

Also, the proposed plans of sustainable structure are shown in figures 1-5. If implemented, the students could be inspired and motivated with improved well-being in this environment.

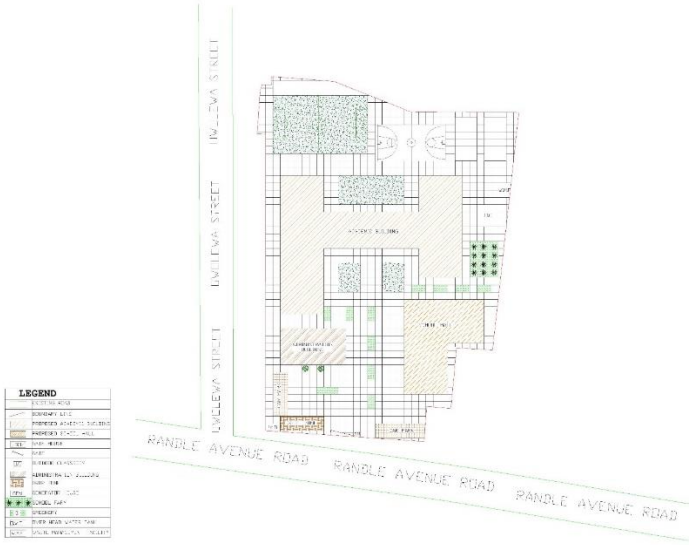

Figure 1: Proposed site plan for Obele Community Senior High School showing the relationship between the different buildings.

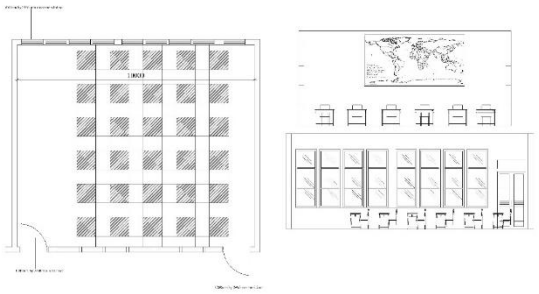

Figure 2: Image showing the proposed views of the classroom [Plan and elevation] for Obele Community High School

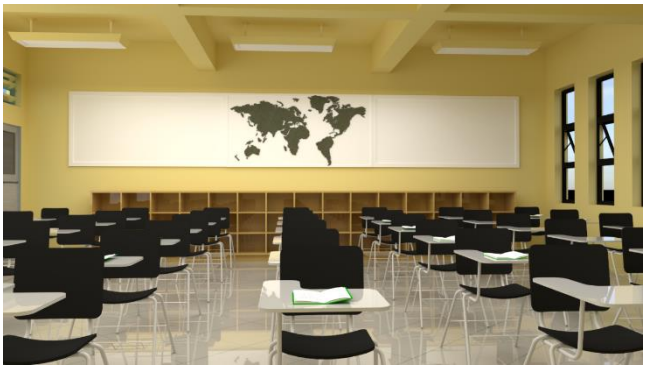

Figure 3: Image showing the interior renderings of the classroom for Obele Community High School

Figure 4:Image showing the exterior renderings of the classroom for Obele Community High School

Figure 5: Image showing the exterior renderings of the classroom for Obele Community High School

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