



Enhancing Accessibility and Daylighting In A Learning Environment

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Abstract

The study of daylight conditions in indoor learning environments has been a topic of interest in developing nations, especially in Africa and Asia, since the nineteenth century. Despite this, it has been argued that having a view outside—or even using daylight instead of more stable and manageable artificial light—could reduce students' success without providing a friendly and safe atmosphere, it appears that there is now widespread agreement on the importance of designing well-daylit spaces. This paper examines how researchers have approached the challenge of comprehending and resolving the dynamic relationships that exist between local climate, user needs, and design constraints in school construction. The case studies presented here, which are focused on either experimental measurements or simulations, emphasize the importance of taking a holistic approach to the subject in order to fully comprehend the non-trivial requirements of a daylit educational setting. This paper reviews the research on daylighting and student success and growth, as well as four case studies of schools that have introduced daylighting in their buildings at a low cost.

Keywords: *Daylighting, school buildings, review, case studies, building simulation*

1. Introduction

What is daylighting? What is a well-daylit space, and why are we seeking it? The first chapter of a newly published handbook on daylighting starts with these basic questions before delving into the many (objective and sometimes subjective) aspects of natural light research in and around buildings in the vicinity of structures. Daylighting is a technique for using daylight to achieve such lighting effects in buildings, such as illuminating a task area, highlighting certain items while obscuring others, or even completely ignoring its contribution in some situations.

Natural lighting was the primary source of illumination in buildings for several years until the late nineteenth century, when artificial lighting was discovered. Architects and building designers considered the importance of natural lighting inside buildings during the last quarter of the twentieth century and the first years of the twenty-first century. In order to minimize energy consumption in buildings and improve indoor living efficiency, daylight has recently become very necessary. "As the National Clearinghouse for Education (NCEF) study found, there is a clear and established correlation between illumination and student achievement. "Do School Facilities Have an Effect on Academic Performance?" According to the NCEF study, there are seven independent studies that show that classroom lighting affects student performance. These studies also show that there are ideal lighting levels for learning, that proper lighting increases test scores and decreases bad conduct, and that daylight encourages students to reach higher levels of achievement. Right lighting is clearly an important aspect of teaching and learning." The aim of this study is to see if the availability of daylight in the learning environment has an effect on student success. Indoor air quality, as well as thermal comfort. Often considered are convenience, acoustics, and artificial lighting. To conduct the study, some educational buildings on campus at various vocational centers as well as

secondary schools, were chosen. The effect of daylighting on student success was assessed using a pre-designed questionnaire and interviews with some students and faculty members. This paper suggests ways of designing and managing learning environments to improve accessibility for students with disabilities.

2. Methodology

This study focuses on the impact of adding daylight to classroom features on students' success over the course of one academic year in a few selected classrooms on the Rivers State University campus in Port Harcourt Nigeria. The output of 400 students in 40 classrooms at the selected buildings is compared using statistical analysis. The classrooms were dispersed across the educational buildings' various floors.

Although taking into account certain common explanatory educational variables, a statistical model was used to investigate the relationship between improved student performance and the availability of daylight in their classrooms relative to the normative criteria for classroom illuminations. Thermal comfort, indoor air quality, acoustics, ventilation, outside window views, artificial lighting, and classroom type are among the physical elements of classrooms that are tested because of their potential impact on student success.

In this research, classroom observations and evaluations of some professors and assistants were conducted to provide additional information for assessing the effect of daylighting and accessibility on student performance.

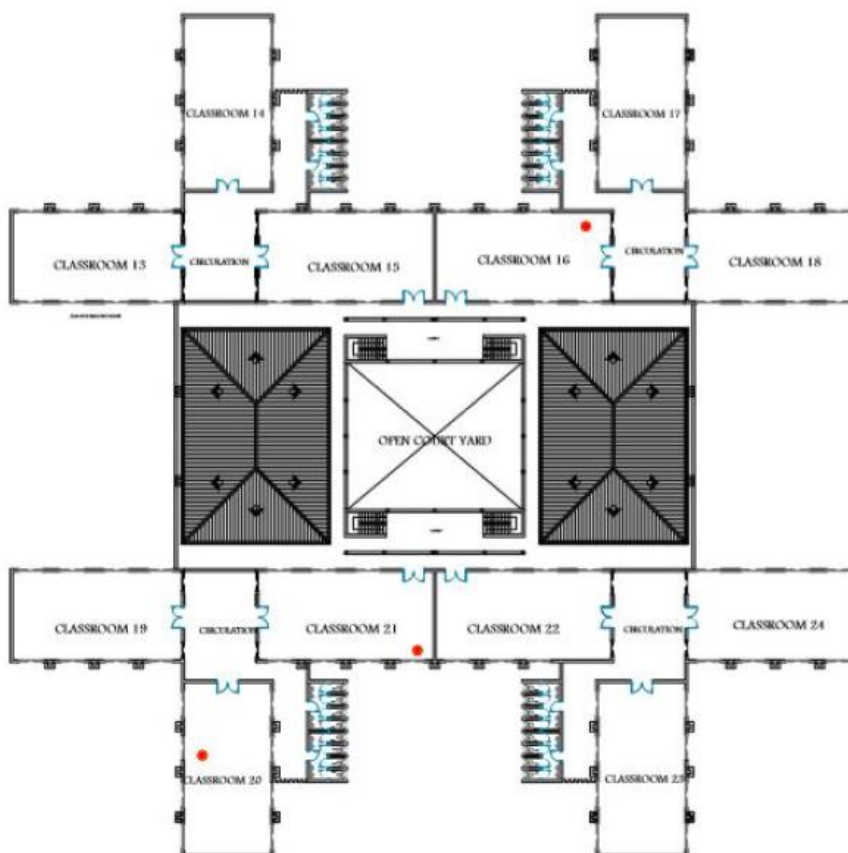


Fig. 3 Floor plans of Architecture department of Rivers State University.

2.1 Delivery of questionnaires

A group of ten students distributed the questionnaire; each student was in charge of the distribution. 40 questionnaires were collected. Table 2 shows the total number of students at the chosen group of faculties. The targeted research sample reflects 5% (188 students) of total students, who were proportionally distributed across faculties. The questionnaires were distributed to 10% of the total targeted study sample, or 382 students, to ensure that this proportion reached the target amount.

Table (2) Distribution of students in the selected faculties

Faculty	Number of Students
Faculty of Education	500
Faculty of Engineering	2,000
Faculty of Environmental Sciences	470
Faculty of Law	410
Faculty of Sciences	380
Total	3,760

2.2 Data entry and analysis

The information from the questionnaire was inserted into the database of the Statistical Package for the Social Sciences (SPSS) program. Each student completed approximately 40 questionnaires and entered them into the database. The relationship between student success and levels of classroom daylight was investigated using a statistical model according to the standard criteria for classroom illuminations. The illumination levels of the selected classrooms were measured using a light meter. Over the course of one academic year, the minimum, maximum, and average illumination (lux) in south and north focused classrooms were determined.

Classrooms	Illumination (lux)		
	Min	Max	Average
Oriented North	980	8,200	3,590
Oriented South	1,400	8,000	4,700

3. Daylighting and accessibility in classrooms

“The impact of lighting on physiology will decrease a student's ability to learn in a school with inadequate light. Poor spectral light can cause eyestrain, which can contribute to decreased productivity. Information processing and learning abilities, as well as increasing stress levels” For a comfortable classroom indoor setting, providing the required level of lighting and uniform distribution of light with an ungeared effect is critical. The lighting in the classroom should be adequate for student tasks such as writing and reading at study tables and on blackboards or bulletin boards. Glare control is important in the classroom, particularly when there is direct sunlight entering the room. A detailed analysis of a variety of factors, such as sunshine angles and other building element modifiers, is needed.

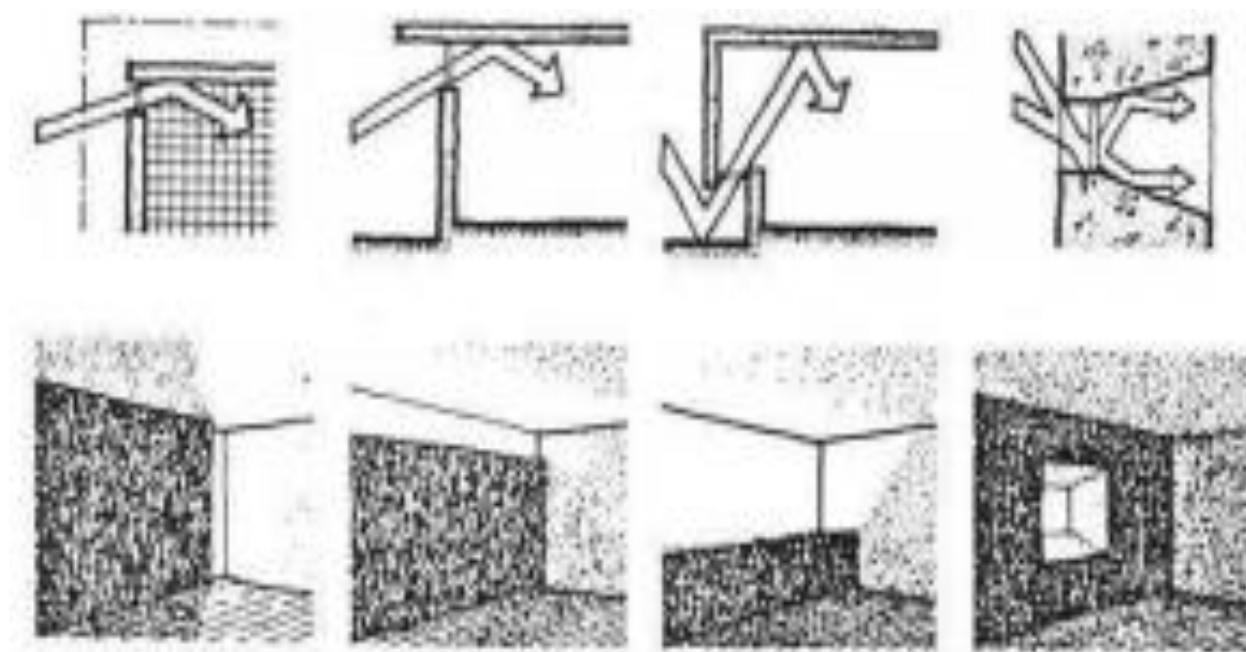


Figure (2) Daylight pattern of side windows and controlling outdoor glare

(Image source : Neufert Architects Data, 3rd edition)

Since and job necessitates special lighting, developing a good definition for natural lighting and becoming mindful of the various activities in the classroom that are influenced by natural light is important. Circumstances Students and faculty members benefit from lighting that facilitates their activities, which necessitates good lighting design to meet their needs, as well as attention to energy efficiency. The European standard EN 12464-1 specifies the lighting requirements for school buildings (Table 1).

Task	The Teacher	The Student	Standard - Luminance	
			In the class	In general
1	Writing on blackboard	Reading on blackboard	500 lux (vertical)	200 lux
2	Talking to students	Paying attention to the teacher	300 lux	300 lux
3	Showing a presentation (slides, PowerPoint, television program, etc.)	Looking at the screen	300/10 lux	10 lux
4	Paying attention to working students	Writing, reading drawing, etc.	300 lux	300 lux
5	Coaching computer activities	Looking to the computer screen and the paper	50 lux	300 lux above the computer
6	Preparing lessons	Not present	300 lux	50 lux

Table (1) Overview of tasks in a classroom together with the requirements for the luminance

4. Benefits of Daylighting and accessibility in Learning environments on occupants

According to recent research, daylighting in schools will help students improve their test scores as well as their health and physical growth without raising the cost of school building or maintenance. One research looked at the test scores of over 21,000 students in Lagos, Ogun, and Oyo state school districts, using multivariate linear regression to account for other factors influencing student success. (1) These are significant findings that have been subjected to stringent statistical scrutiny. Students with the most daylighting in their classes advanced 20% faster on math tests and 26% faster on reading tests in one school district as compared to students in schools with the least amount of natural light. Students in schools in the other two school districts. Those who had the most daylighting had 7 percent to 18 percent higher scores than those who had the least. In another report, students in three Lagos state Government schools were compared to students in the county school system as a whole and other new schools throughout the county. Over 1,200 students in daylit schools had their test scores compared to the county's students. Students who attended daylit schools outperformed students who attended non-daylit schools by 5% to 14%, according to the report. According to two reports, daylighting in classrooms will help students' overall health and progress. Researchers studied 90 Port Harcourt school students in a survey. Over the course of a year, researchers studied behavior, wellbeing, and cortisol (a stress hormone) levels in four classrooms with

differing daylighting levels. The findings suggest that working in classrooms without natural light will disrupt the basic hormone pattern, which can affect children's ability to focus and cooperate, as well as annual body growth and absenteeism.

Furthermore, schools discovered that raising the amount of daylighting in a school's design did not always result in higher construction and operating costs. Application elements such as light sensors are incorporated, and mechanical and electrical systems are optimized as a result of reduced costs. Because of the smaller size and lower cost of HVAC equipment, cooling and lighting loads will actually lower the initial capital cost.

5. Results of findings

Results The results of the measurements are shown in Table (3). Key findings are summarized below.

- The illumination in most of the north and south oriented classrooms during most of the year was above 500 lux.
- The average illuminations in the south oriented classrooms were higher than the north oriented classrooms.
- Some upper floors north and south oriented classrooms were affected by skylight contributions.
- The illumination was almost equals in both south and north oriented classrooms.
- The average illumination for all the year in the south oriented classrooms was 4,700 lux, and in the north oriented classrooms was 3,590 lux.

6. Conclusions and Recommendations

Construction costs for schools do not reflect a major cost improvement over conventionally planned schools thanks to innovative and resourceful design techniques. Colleges and universities Furthermore, students who attend these schools' benefit from daylighting in terms of improved academic success (as assessed by test scores) as well as general health and well-being.

Among the design techniques are:

- Using funds previously allocated to building exteriors and hallways to finance daylighting features in classrooms.
- Orienting the structure to optimize daylighting efficiency while minimizing unwanted heat gain.
- Downsizing the cooling system, lowering utility and operations and maintenance costs, which both reflect significant cost savings, offsetting much or all of the cost increases associated with daylighting functionality.
- Encouraging whole-building architecture by improving mechanical system sizing and building system coordination (for example, motion sensors and light level sensors switch off or dim electric lights when there is enough daylight).

- The building is oriented to allow optimum light in from the north and south sides, which is beneficial.
- To maximize daylighting, clerestory windows are used on the south-facing classrooms, rather than the east and west sides, which result in unnecessary heat gain. The clerestory windows are made of polycarbonate, which provides a reflective surface for light to pass through while being lighter and less prone to breakage than glass. By bouncing light through the clerestories, a slanted metal roof will maximize daylighting.
- All windows at eye level use an 8-inch green-tinted, infrared-absorbing glass
- The north-facing classrooms have tall studio style windows, which are very useful in Austin's climate.
- Optimized mechanical system is designed specifically for the building to improve energy efficiency and lower operating and maintenance costs. The sloping metal roof, which is currently in conceptual design, will also be used to capture rainwater for the cooling tower; water is normally purchased from the city resulting in considerable cost savings.

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Owor Gandhi holds a B.Tech degree in Architecture from Rivers State University in Nigeria. He is currently undergoing his MSc program in architecture in Rivers State. He is compelled by sustainable designs that are region effective. His interests range from sketching, modeling, painting and is skilled with musical instruments.

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