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PARAMETRIC MEASURES FOR DESIGN WORKSPACE ADEQUACY OF SELECTED INSTITUTIONS IN NIGERIA

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ABSTRACT

Architectural or Engineering design workspace is an arena where denominator activities takes place, however its adequacy has been neglected over the years. This study focused on parametric measures to ascertain design workspace adequacy of selected institutions in Nigeria. Questionnaires with multiple-choice and open-ended questions were administered to undergraduate and postgraduate architecture students of four (4) schools in south-west Nigeria. The sustainable parametric measures of adequacy that were examined include: workspace, lighting, ventilation, safety, privacy and security, building service equipment and the auxiliary facility requirements in the design studio. The outcome of the study revealed parametric indices in line with the sustainable measurements of adequacy. It highlighted other grey areas of adequacy not yet addressed. It also suggested the harmonization of design workspaces in line with tropical and universal standard. Recommendation was also given of energy the design of workspaces in other allied professions i.e civil, electrical, and mechanical engineering spaces.

Keywords: workspace, architecture, design, adequacy, parameters.

1. INTRODUCTION

The quality of a design studio contributes to the effectiveness in delivery of architectural projects. Based on peculiar morphological characteristics, design studio is an arena where denominator activities of design take place. It offers a prime example of a collaborative, multi-sensory, learner centred, constructivist, and experiential problem-based teaching environment (Salama, 2006). Traditionally, it offers a pleasant environment for learning, promoting a one-on-one learning with students arranging their own drawing tables, papers, books, pictures, drawings and models (Aderonmu, 2013). In the workspace, students spend much of their learning time interacting together, but often engaged in private or parallel pursuits of the common design task (Schon, 1983). School environment has been recognized as an important factor in academic performance, personal development, relationships among students and teachers, and students' mood, attitudes, and behaviours (Fraser and Fisher, 1983). Due to differences in climate, culture and educational systems, studies conducted in the non- tropical zones have little relevance for understanding the situation in Nigeria situation as found in similar parts of the world (Moos, 1974; Salama, 2006). Thus, the goal of this study is to examine the quality adequacies of the architectural design studio environment in the selected schools as it related to the Classroom Environment Scale (CES) Moos, 1974). The dimensions measured were the quality adequacies as it satisfied the users (students), in terms of requirements quality of architectural design studio environment. This was evaluated by considering the quality of the adequacy requirements as specified by benchmark parametric measures in terms of design work space (MASDS), lighting (MASL), ventilation (MASV), safety and security (MASSS), privacy (MASP), studio building services (MASBs), and auxiliary facilities (MASAF) for the four (4) selected schools of architecture in the south-west Nigeria.

Architectural professional bodies and societies of architectural educators are now paying attention to the issue of sustainable designs as a means of reducing the impact of the built environment on the ecosystem (Stevenson et al., 2009). Ibrahim (2008) however observed that although architects acknowledge the importance of sustainability, one of the major setbacks to the practice has been the limits of the knowledge of the architects. There is therefore a need to reconsider the sustainability education that the architect receives. This inference can be drawn from the fact that deficiencies in educational curriculum has been identified as the bane of sustainable development (Myers (2012), suggesting that designers may not be equipped to rescue the environment. However, sustainability is yet to become one of the accreditation criteria of architecture schools in Nigeria. As a result, Elnokaly and Elseragy (2009) opined that architecture schools address the issue of sustainability in a superficial manner, often left at the discretion of individual tutors. This assumption however remains to be tested in the case of architecture schools and other allied professions in Nigeria. Hence, this study investigates the adequacy of the architectural design studio spaces in addressing the hot philosophical debates on sustainability.

The study was centered on different key areas, which include: areas of adequacy the design studio workspace should address, positioning of lighting in design studio space, how ventilation does affect the comfort of a design studio space, level of priority of safety and security in the design studio space, privacy matters in the arrangement of your design studio space, building services installed in the design studio space, and lastly,

auxiliary facilities in the design studio space. A study of this nature is important because it will provide stakeholders with an understanding of the state of the architectural design studio and be able to meet up with the parametric measures required for accreditation, professional competency and proficiency of the future architects in terms of sustainability. More importantly, the designers of the future would be well equipped to handle client-users' space optimization in line with tropical (Stasinopoulos, 2005) and universal design standard for the training of architects to address sustainability issues in professional engagements and practices.

2. LITERATURE REVIEW

2.1 The architectural design studio environment- as workspaces

Studio environment is a learning, teaching, workspace, and place of interaction between students, faculty, emerging professionals, practice leaders, community leaders and other professionals Kuhn (2001). Also, in line with Lewin's theory, Schein, (1992) described architectural design studio environment as one that should have collaborative practice and flexible solutions, and ensures explorations, participation and discussions. Architectural design is ultimately an activity intended for the improvement of the environment and the societies and individuals that occupy it.

Design is a culture accentuated by the availability of working resources (library, computer, workshop, etc.) and the collaboration between students, faculty and guests from a variety of disciplines and backgrounds. Albeit, the school believes that the studio environment is a physical, psychological, virtual and intellectual (disciplinary) entity which should be conducive toward the productive and unconstrained implementation of ideas.

2.1.1 Environment theories, scales and dimensions

The school environment could be social, psychological, physical and virtual (distance education). The main objectives of researching around design studio environment are to: develop the traditional studio environment and validate a new learning environment instrument, describe studio learning-working environment perceptions of Students and Teachers, identify associations between learning environment factors and students' satisfaction, and inform the students, instructors and practitioners about the adequacy parametric scales of studio workspace environment. Relevant learning environment scales were considered in the selected Nigeria schools namely; the psycho-social, virtual and physical environments.

2.1.2 The Psycho-social environment: historical perspective

Psychosocial environment employs the combination of two 1930s psychosocial theories of Kurt Lewin - psychological field theory which stated that the environment influences the person and the person influences the environment. This is true in architectural design studio environment. A learning environment that possesses a creative look in form and organization is likely to have a great influence in design thinking and product of students, while a grandeur outlook of studio setting can stimulate appetite for good learning and teaching.

Murray also established in his personality theory that behaviour is a function of a person and his environment, that is, B = f (P, E). Henry Murray established the following parametric associations: P = Person, E = Environment, f = function of P and E, B = behaviour. Also, Kurt Lewin's purpose was to conceptualize human behaviour where relationships and states of interaction are emphasized of simple responses to stimuli. The Influence of the 1970's environmental awareness is also very imperative but: Moos' five conceptions of how environments work will give another perspective of effective learning environment: Increases in the awareness of and actions related to the natural environment during the 1970s led to an increase in interest in human environments among researchers. Moos called these, when interrelated, a social ecological approach to help us comprehend the influence of psychosocial environments. From this evolved three psychosocial dimensions, which includes: Relationship Dimension, Personal Development (growth) Dimension, System Maintenance and Change Dimension (Moos, 1974)? From subsequent work, Moos has been able to demonstrate that enduring quality of these dimensions in terms of family, work, school, health, military, prison and community social contexts (Moos, 1974). The relationship dimension distinguishes the nature and strength of personal relationships. This is the extent to which people work with one another and support and assist one another. Terms related to this dimension include: cohesiveness, expressiveness, support, involvement and affiliation.

Drawing lessons from Moos categorical statement, "it is through the framework of these dimensions that investigators can characterize and integrate the impacts social environments have on individuals and groups. Psychosocial environments tend to preserve the individual characteristics that are compatible with their prevailing aspects (Moos, 1974).

2.1.2.1 Perceptual indexes to measure these dimensions

Another researcher in the stake holding dimension of environment is Walberg who suggested that learning is a function of aptitude, instructional treatment and the environment. Also, that, instructors often measure only aptitude (A), and we often attempt to manipulate only treatment of instruction (T). Most educators unconditionally adopt $L = f(A, T)$. However, $L = f(A, T, E)$ is likely more in line with reality. These equations demonstrated association between learning environments and student outcomes. It stated that learning is a function of aptitude and instructional treatment. Numerous studies during the late 1970s and into the 1980 demonstrated a strong association between psychosocial classroom characteristics and learning achievement.

2.1.3 Virtual environment

This includes the constructivist, e-learning environment, distance learning educational environment. It is a distance education research is dominated by: Student outcomes (achievement, scores), Student and instructor attitudes, technology, role of the instructor, and Program implementation/system evaluation. Distance education literature dominated by unoriginal study, anecdote, and a myriad of taxonomies. These taxonomies includes: Pedagogy, communications, knowledge attainment, and many others. Computer-mediated distance education has a distinctive social structure. There is gap in literature in that "some rich traditional values of learning environment have been eroded in the disguise of 'euro centrism'. This is related to distance education learning environment character and types of learning environments that enhance learning and good culture.

In Nigeria, there has been no tangible research on comparative characteristics of physical psychosocial environment, and virtual environment and even the affective perceptions of Environment by students in Schools of Architecture.

2.1.4 The physical environment

This is the traditional physical space where architectural studio offers a prime example of a collaborative, multi-sensory, learner-centred, constructivist, experiential problem-based teaching environment. Usually, it is a pleasant studio space, from ten to as many twelve students to a professor (teacher/instructor) ; arrange their own drawing tables, papers, books, pictures, drawings, and models. In this spatial environment, students spend much of their working lives, at times talking together, but mostly engaged in private, parallel pursuits of the common design task (Schon, 1983). Some notable variables during desk crit in traditional physical studio environment are attitudes, thinking pattern, nature of work, progress chart, and associated problems with assignment (Schein, 1992).

2.1.5 Learning environment scales

The following environment scales guides this work in determining the measuring scales and parameters for architectural design studio space dynamics. They are: (i) Instructor Support: the extent to which the teacher is approachable and responds quickly with feedback (ii) Student Interaction and Collaboration: extent to which students have opportunities to interact with one another, exchange information and engage in collaboration (iii) Personal Relevance: "Connection between students' out-of-school experiences" and their classroom experiences (iv) Authentic Learning: extent to which students have the opportunity to solve real-world problems that are authentic (v) Active Learning: extent to which students have the opportunity takes an active role in their learning (seek own answers, solve own problems, explore learning strategies) (vi) Student Autonomy: extent to which students have opportunities to initiate ideas and make their own learning decisions, and the locus of control is student oriented.

As can be seen in Table-1, the significant variables across the theoretical spectrum are interactivity and cohesiveness of the users and the dynamics of studio space (learning working) environment. Therefore, in the methods considered for this study, the interplay of these variables was considered as guides in determining the adequacy parameters of design studio spaces.

Table-1. Learning environment scales and characteristics.

DOLES (1995): Distance and open learning environment survey	Characterized by: Student cohesiveness, instructor support, personal involvement, task orientation, home environment
CVLES (2000) Constructivist Virtual Learning Environment. Survey (CVLES)	Characterized by: Relevance, reflection, interactivity, instructor support, Interpretation
DELES Distance education learning environment instrument scale	Characterized by: -Student Interaction & Collaboration,-Personal Relevance -Authentic Learning, -Active Learning,-Student Autonomy and Enjoyment (satisfaction)

(Source: Moos, 1974).

3. METHODOLOGY

Out of the eight accredited schools of architecture in south-west Nigeria, the design studio spaces of four (4) were selected for the study. These were University of Lagos (UNILAG), Ladoke Akintola University of Technology, Ogbomoso, (LAUTECH), Obafemi Awolowo University (OAU), Ile-Ife, and Covenant University (CU), Ota. The design studios were both quantitatively and qualitatively analyzed for adequacy parameters. The unit of analysis is the architecture schools. The content of the design studio were analyzed to identify where and how the parameters of adequacy were addressed in the institutions studied. A survey of architecture students in Covenant University from the third to the sixth year was carried out in between 2013/ 2014 academic session. The entire student population was taken as the sample size, giving a total of 609 students with 525 respondents in the four (4) selected schools. The students were asked to fill a questionnaire, which consisted of three sections. A section of the questionnaire consisted questions on the adequacy parameters of the design studio spaces; the students were asked to indicate on a five-point

Likert type response, their agreement with statements suggested their perception on the adequacy parameters of the selected design studio spaces under study. The responses vary from 1- very inadequate to 5-very adequate. The data obtained were analyzed using descriptive statistics. Only 525 questionnaires were returned giving a response rate of 86.2 percent.

4. RESULTS AND DISCUSSIONS

4.1 Space requirement for architectural design studio

The factors considered for quality of architectural design studio environment across the four (4) selected schools were namely: General spaces in design studio, individual spaces, number of studio spaces, and size of drawing boards.

Table-2 presents the cross tabulation of general spaces in design studio across the four (4) selected schools, the majority 286(61.2%) of the respondents as students (users) disclosed that the general spaces in design studio were adequate; while a few 68(14.5%) described their studio spaces as inadequate. Therefore, the implication of this result indicates that there were still few general design studio spaces that are yet to be made good. This may have a consequential effect on the performance of affected respondents (students). While those with adequate general spaces are enjoying their work interactively others may be suffering from acute manoeuvring of their general design studio spaces, poor relationship, and unproductive thinking habits.

Table-2. Cross tabulation of general spaces in design studio across the Four (4) Selected Schools.

University	General spaces in design studio					Adequacy frequency (%)	Unit adequacy measure (%)	Total
	very inadequate	inadequate	fair	adequate	very adequate			
UNILAG	13(11.3)	16(13.9)	19(16.5)	51(44.3)	16(13.9)	67(58.2)	14.3	115(100.0)
O.A.U	3(2.6)	8(7.0)	25(21.9)	66(57.9)	12(10.5)	78(68.4)	16.7	114(100.0)
CU	4(3.3)	15(12.2)	36(29.3)	55(44.7)	13(10.6)	68(55.3)	14.6	123(100.0)
LAUTECH	4(3.5)	5(4.3)	33(28.7)	48(41.7)	25(21.7)	73(63.4)	15.6	115(100.0)
Total	24(5.1)	44(9.4)	113(24.2)	220(47.1)	66(14.1)	286(61.2)	61.2	467(100.0)

(The figure in bracket are in percentages and the figure outside are frequencies)

Also, Table-3 shows the synthesis: space requirement quality of architectural design studio environment. The most significant index (69.9) for determining the quality of architectural design studio environment was the number of studio spaces for respondent users per school. Figure-1 presents the space requirement quality for architectural design studio environment**.** The result shows across the selected schools that CU had a stronger index (18.8) for number of studio spaces, next to it was O.A.U (17.6), and followed by UNILAG (17.3), while LAUTECH (16.2) had the least index of number of studio spaces for respondent users.

The implication of these results hinges on the bench mark-enrolment standards into the schools of architecture, as each school must try to improve on the design studio capacity. This is to enable the studio users to have enough capacity in other to establish a leverage to match with the challenges being faced by schools on the enrolment issues. In some of Nigerian schools and others around the world today, studio space capacity had been a major challenge for which most users find insufficient tools to work with, and when available, some of them were in depreciated conditions.

Table-3. Synthesis: Space requirement quality of architectural design studio environment.

University	Space requirement quality of design studio environment				
	General spaces in design studio	Individual spaces in design studio	Number of studio spaces		Size of drawing boards
Respondents(N)	467	469	469		469
UNILAG	67(58.2)	86(74.1)	81(69.3)	Significant indices 17.3	80(71.4)
O.A.U	78(68.4)	77(67.0)	83(73.4)	17.6	69(60)
CU	68(55.3)	69(56.1)	88(71.5)	18.8	69(54.4)
LAUTECH	73(63.4)	45(39.1)	76(65.5)	16.2	90(78.8)
Total	286(61.2)	277(59.1)	328(69.9)	69.9	308(65.7)

The figure in bracket are in percentages and the figure outside are frequencies

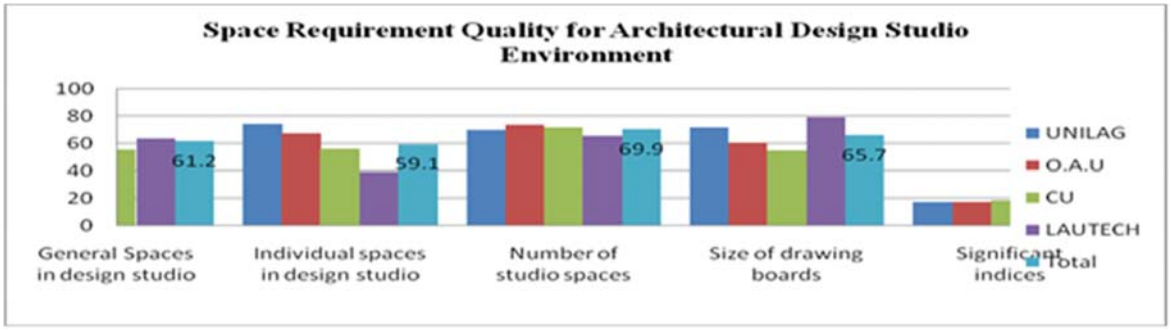

Figure-1. Showing the space requirement quality for architectural design studio environment.

From the results, it was therefore noted that the concerned schools of architecture should strive to first achieve the benchmark standards as prescribed by accredited agents, maintain it and continuously navigate it to sustainability arena. According to observation and the results of survey from respondents, the average number of design studio spaces was about 50 users per studio's space.

The architectural design studio environment needs to be made appropriate for learners; it increases the level of performance and assimilation. The space requirements for effective workspace affect the speed, social-interaction, thermodynamics, and airflow (velocity, mass flow rate, volume flow rate) and general performance of learners. Table-4 shows the design studio space-environment as predictor of pedagogy (the factor analysis), the general space requirements in the four (4) selected schools as determined by the mean adequacy scores for space (MASDS); the majority of the respondents 396 (86.3%) described the general studio space as very adequate, while 63 (13.7%) describe it as inadequate.

Table-4. Design studio space-environment as predictor of pedagogy (The Factor analysis).

Predictors of pedagogy	Standard beta value	Standard error	df	F-Value	Significant (P-Value)
Mean Score for Ventilation Requirement	-.008	.023	1	.115	.735
Mean Adequacy Scores for Lighting Services	.217	.030	2	53,434	.000
Mean Adequacy Score for Privacy	.036	.022	1	2.583	.109
Mean Adequacy scores for Studio Building Services	-.113	.027	5	17.000	.000
Mean Adequacy Score for Auxilliary Facilities	-.130	.024	2	29.227	.000

4.2. Lighting requirements for design studio: Mean Adequacy for Lighting Requirements in Design Studio (MASL) for the selected schools

The luminous intensity required on the architectural design studio space is an important factor necessary for studio learning and performance. It brings a designer closer to the nature. This is distributed over the entire space area to lighten the learning-working environment. Figure-2 shows the integration of natural lighting into the design studio spaces. Three quality attributes were considered for good lighting requirements for architectural design studio they are: integration of natural lighting into the design studio spaces, effective natural lighting on the drawing tables, spaces between drawing tables. The adequacy of lighting depends on the location and size of the window, geometrical content of the space-length, breadth and height, colour on the wall finishing, reflection and other luminous factors. Among the lighting requirements considered for the quality of design studio environment, the integration of natural lighting into the design studio spaces was the most significant 306 (66).

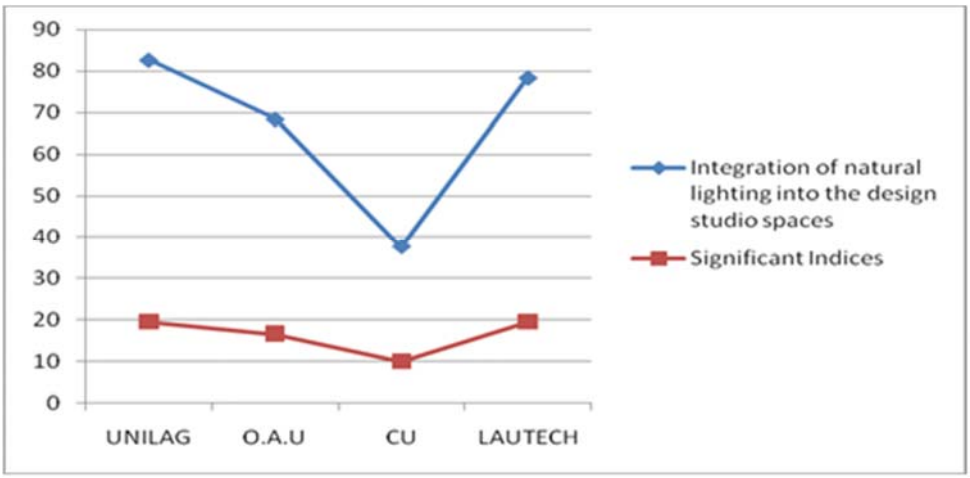

Figure-2. Showing integration of natural lighting into the design studio spaces.

From Table-4 and Figure-2, according to the respondents' perception, both UNILAG (19.6) and LAUTECH (19.6) had the highest adequacy indices in terms of the natural lighting integrated into their architectural design studio spaces. Table-5 shows the synthesis lighting requirement for the quality of architectural design studio environment. Also, next to this was the arrangement of spaces between drawing tables and the least significant index was the effective natural lighting (daylighting) on the drawing tables (Figure-3).

Table-5. Synthesis lighting requirement for the quality of architectural design studio environment.

University	Lighting requirement for the quality of design studio environment			
	Effective natural lighting on the drawing tables	Spaces between drawing tables.	Integration of natural lighting into the design studio spaces	Significant Indices
Respondents(N)	472	472	465	
UNILAG	90(79)	86(75.5)	91(82.7)	19.6
O.A.U	85(73.9)	73(63.4)	78(68.4)	16.7
CU	63(49.6)	58(45.7)	47(37.6)	10.1
LAUTECH	56(48.3)	89(76.7)	91(78.4)	19.6
Total	**294(62.3)**	**306(64.9)**	**307(66)**	**66**

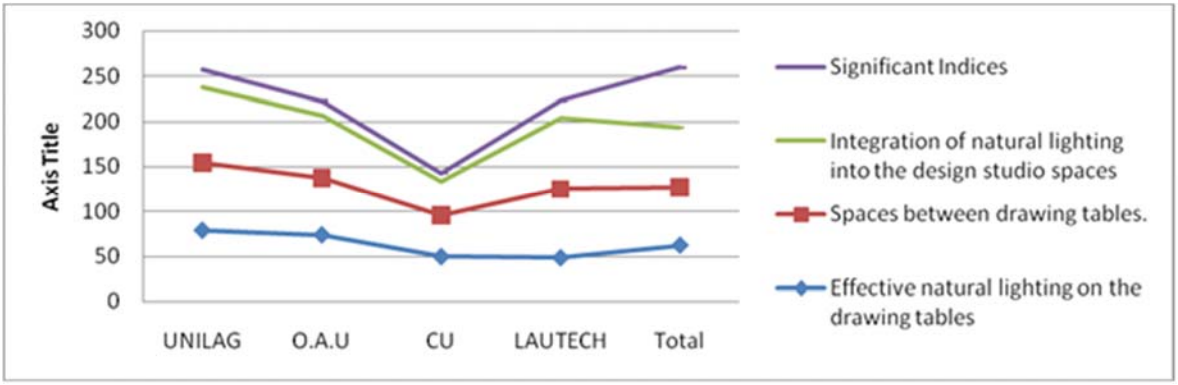

Figure-3. Showing lighting requirement for the quality of design studio environment.

According to these results, the effective natural lighting (daylighting) on the drawing tables was the least quality of lighting requirements in the design studio environment. It implies that the essence of daylighting had been replaced in these studios with artificial lighting systems, thereby undermining the efficacy of daylighting: the purpose of effective natural (day lighting) lighting in architectural design studios was to enable the various users to optimize the use of broad day at least in tropics, the users would be able to work from 7am to 7pm daily on a less cloudy days.

The aims are then to adequately satisfy by illuminating the visual tasks effectively on drawing tables or boards, to create an attractive (mood) visual environment, and to save electrical energy.

The increasing tendency to replace heating, ventilation, and air conditioning (HVAC) plants with hybrid HVAC- thermal lighting or hybrid natural ventilation strategies will affect the building envelope design. Therefore, generally, the issues on sustainability: renewable energy (RE) and daylighting (DL) needs to be given priority in these selected studios- most urgently where it has lesser indices in the schools investigated.

4.2.1. Lighting performance and satisfaction of learning environment

From the results stated above and coupled with on site observation, generally in the four (4) selected schools, the architectural design studio environment was found as good luminous environment. But adequate attention must be paid to effective lighting on drawing tables and sufficient passage between the tables. The adequacy of lighting is a luminous quantity (quantitative requirement) which depends on the visual task: the contrast, the fineness of detail and the speed at which the view changes. It therefore means that effective flux entering the design studio workspace greatly affect the performance of any given task in the design studio and its environment. It helps to satisfy the exigencies of the amount, intensity and quality of light (artificial and natural) required for the performance of a given task, the direction and source of the light and the glare control across the viewing surface; for excess glare could cause thermal discomfort to the users.

The suitability of lighting is an adequacy (qualitative) requirement and has at least four components: (a) colour appearance and rendering (b) colour appearance of an environment as associated with mood and the expected 'atmosphere'. These have psychological and aesthetic effects which affects the architectural character and behavioural tendencies of a space. From the four (4) selected schools, the degrees of lighting adequacy were generally good. But some other factors may still be considered for further enquiries on the sustainable issues on overheating as pertain to the tropics and under heating with specifics to other regions of differential climatic records. Transference application of these results could also be useful in a library, study room design and any other allied space analogical to this study (design studio workspaces).

Table-6 shows the average results for the four selected schools. The attributes of the lighting requirements for the architectural design studio considered were: integration of natural lighting into design studio, effective natural lighting on the drawing table, and spaces between drawing tables.

Table-6. Mean adequacy scores for lighting in architectural design Studio (MASL) across the four selected schools.

Class interval(of Mean adequacy score for lighting requirements)	Frequency
1-2	25(5.4)
2.33-2.67	47(10.1)
3-3.67	134(28.8)
4-5	259(55.7)
Total	465(100)

The figure in bracket are in percentages and the figure outside are frequencies
Source: Aderonmu, 2013

The findings from the statistical tables show a majority of respondents 259(55.7) who disclosed that the lighting standard was very adequate; while a few 25 (5.4%) described it as very inadequate generally across the four (4) selected schools. This signified averagely, good

luminous environment of the four selected studios across the four (4) schools that were investigated.

4.3. Ventilation requirement for the quality of architectural design studio environment

The three distinct purposes of ventilation is to (1) supply fresh air, remove smells, carbon dioxide, and other contaminants (2) remove some internal heat when extern temperature is less than internal temperature (3) promote heat dissipation from the skin i.e physiological cooling.

Table-7 presents the synthesis for ventilation requirement for the quality of architectural design studio environment. The design studio configuration, the requirements considered paramount were: (i) circulation of fresh air in personal working spaces (ii) General circulation of fresh air in design studio space (iii) level of thermal comfort in design studio.

Table-7. Synthesis: Ventilation requirement for the quality of architectural design studio environment.

University	Ventilation requirement for the quality of design studio environment			
	General Circulation of fresh air in design studio	Level of thermal comfort in your design studio	Circulation of fresh air in personal working spaces	Significant Indices (%)
Respondents(N)	476	476	469	
UNILAG	74(62.7)	80(67.8)	81(72.3)	17.3
O.A.U	37(32.2)	25(21.7)	37(32.2)	7.9
CU	55(42.3)	49(38.5)	54(42.5)	11.5
LAUTECH	84(72.4)	83(71.5)	88(76.5)	18.8
Total	250(52.5)	237(49.8)	260(55.5)	55.5

The Figure in bracket are in percentages and the figure outside are frequencies

The result in Table-7 shows that in the design studios of the four (4) selected schools, the most significant 260 (55.5%) in the ventilation requirement considered in the design studio quality for ventilation requirement was the circulation of fresh air in personal working spaces. Figure-4 showing ventilation requirements for the quality of design studio environment. Among the four selected schools; according to these results, the highest index was from LAUTECH (18.8), next to it was UNILAG and the least from O.A.U (7.9). From personal observation, although, the geometrical form of O.A.U architecture school was inspiring and with a grandeur style, but possibly, the architectural master piece, especially the geometry of pagoda roof may need to be further manoeuvred by exposing more of its mass to the skyline for greater sustainability. Also more to be considered in the affected studios were the geometrical proportions as expressed by the room index (RI), reflectance of ceiling and walls surfaces, type of fenestration and the positioning of workspaces points relative to the windows.

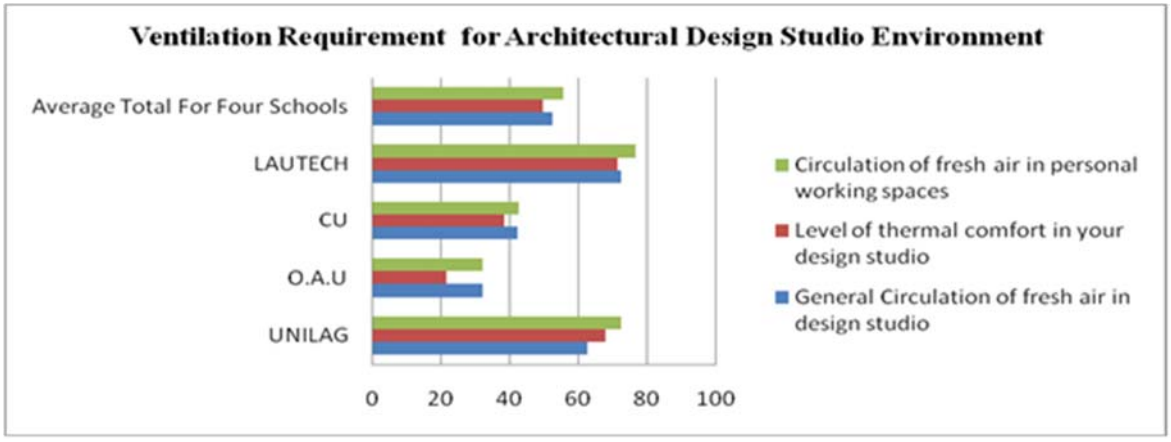

Figure-4. Showing ventilation requirements for the quality of design studio environment.

The result in Figure-4 and Table-7 indicates that among the three criterion investigated for quality of ventilation requirements for architectural design studio environment, the circulation of fresh air for personal

working places was most significant 260(55.5%) while level of thermal comfort 237(49.8%) was the least with a slight variation in UNILAG.

It implies that although three factors may all be important but on the scale of preference averagely for the for selected schools, the issues on circulation of fresh air for personal working places was given more adequate attention than general circulation of fresh air in design studio and level of thermal comfort as the least.

In a precise term, thermal comfort of a particular room situation is described by its thermal characteristics: air movement, air velocity, humidity and radiation. In this case, these characteristic factors, in the design studio, determines how long or short one will stay to work, if the thermal comfort level is low, the various users would be enfaced with uneasiness, drowsiness, dizziness, boredom, fidgeting, perplexing and other anti- physiological factors. A sensible level of air velocity, air movement, humidity and radiation can be relied upon to provide physiological cooling in the workspaces of architectural design studio environment.

4.3.1. Thermodynamics for the quality of design studio environment and 'deserted studio'

Thermodynamics is simply the environmental science of heat exchange; as relevant to architectural design studios is hinged on the principle of thermal comfort and its balances. Figure-5 presents the thermodynamics for the quality of design studio environment. Two parameters considered were the circulation of fresh air in personal working spaces and level of thermal comfort in design studio. A lot of activities are always in place during studio hours, varying from conceptual thinking to drawings, desk crits, one-to-one communications, and movement from one table to another by both the students and their instructors. In environmental thermodynamics, the human body continuously produces heat by its metabolic processes. This heat must be dissipated to the environment, or else the body temperature will increase. However, a good level of thermal comfort is required for speed, concentration on drawings, assignments and any given task. This affects the condition of mind that expresses satisfaction with the thermal environment. Figure-5 presents the thermodynamics for the quality of design studio environment.

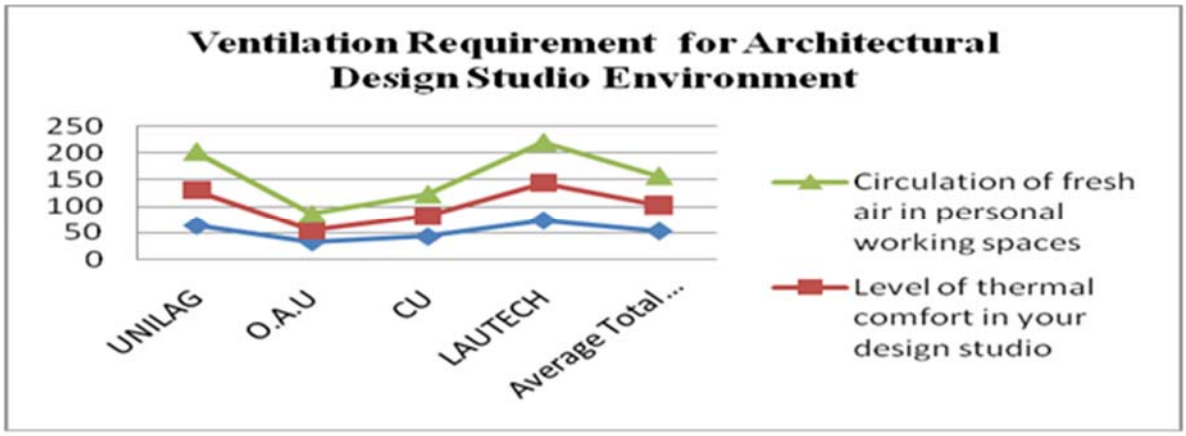

Figure-5. Thermodynamics for the quality of design studio environment.

4.3.2. Thermal characteristics and comfort level in architectural design studio

From the foregoing, thermal comfort was described in form of its characteristics: air temperature, air movement, humidity and solar radiation. In the design studio learning environment, air temperature is the dominant environmental factor, as it determines convective heat dissipation. Air movement accelerates convection, as well as increases evaporation from the skin, thus producing physiological cooling. Subjective reactions to air movement are stuffy (<0.1 m/s), unnoticed (to 0.2m/s), pleasant (to 0.5m/s), awareness (to 1m/s), draughty (to 1.5m/s), and to annoying (>1.5m/s). But under overheated conditions air velocities up to 2m/s may be desirable for design studio learning environment.

Medium humidity (30% to 60%) do not have much effect, but high humidity restrict evaporation from skin and in respiration, and thus curbed the dissipation mechanism, whilst very low humidity lead to drying out of the mucous membranes(mouth throat) as well as the skin, thus causing discomfort in the design studio learning environment. Therefore, from Table 7, where the thermal comfort was acutely low i.e in O.A.U 25(21.7%) and C.U 49 (38.5%); strategies need to be incorporated to adjust the space mechanism for these affected design studios.

4.4 Mean Adequacy Score for (MASV) for Ventilation of architectural design studio environment

Table-8 shows the ventilation requirement is also calculated by mean adequacy scores (MASV) for ventilation. It is therefore evident from the above data that a handful some of the respondents 181 (38.6%) signified higher levels of adequacy (adequate to very adequate), next to it was 147(31.3%) respondents who disclosed the

adequacy as fair, and respondents 141(30.1%) who described the ventilation as very inadequate and inadequate for architectural design studio environment as a whole .

Also, the results of these requirements are pointers to climatologic levels (thermal comfort and conduciveness) in the selected studios. There is therefore, a direct influence of the ventilation (artificial or natural) requirements on the performance and productivity of the respondents.

Table-8. Ventilation requirement for architectural design studio environment: Mean score for ventilation requirement (MASV).

Class interval (of Mean Adequacy score for Ventilation Requirements)	**Frequency**
1-2	48(10.3)
2.33-2.67	93(19.8)
3-3.67	147(31.3)
4-5	181(38.6)
Total	469(100)

The figure in bracket are in percentages and the figure outside are frequencies

4.5. Safety and security requirement for the quality of design studio environment

Among the five (5) indices of safety and security requirement for the quality of design studio environment, according to the result in Figure-6 and Table-9 (a) and (b). The highest significant index 228(48) was a fire safety measure in the architectural design studio. It implies that among other factors, the four selected design studios were well equipped with safety equipment as compared to other safety and security measures. Although, the highest index (48) was still low; when one consider the valuable lives, properties and equipment that these design studios accommodates.

On the individual school basis, from Table-8, the result according to respondents shows that CU had the highest (15.8) significant index of fire safety measures in their design studio; next to it was LAUTECH (13.3), UNILAG (10.5) and the least from O.A.U (8.4). The observation during the field work confirmed these. Also, in UNILAG design studio, an increase in the fire safety measures was recorded as addendum few months after the collection of this data; it was later fortified with new fire safety equipment and measures (newly equipped design studio) during the facelift works of studio renovation.

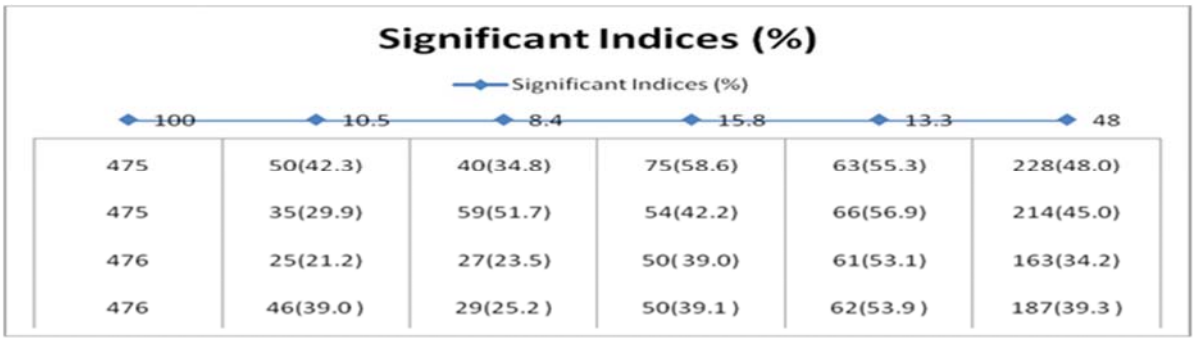

Figure-6. Measures of significant indices for fire safety in selected schools.

Table-9 (a). Safety and security requirement for the quality of design studio environment.

University	**Safety and security requirement for the quality of design studio environment**					
	Protection against noise pollution	**Protection against dampness in design studio**	**Protection of studio against insects, rodents and reptiles**	**Security measures in your design studio**	**Fire safety measures in your design studio**	**Significant indices** (%)
Respondents(N)	475	476	476	475	475	
UNILAG	42(35.6)	46(39.0)	25(21.2)	35(29.9)	50(42.3)	10.5
O.A.U	18(15.8)	29(25.2)	27(23.5)	59(51.7)	40(34.8)	8.4
CU	48(37.8)	50(39.1)	50(39.0)	54(42.2)	75(58.6)	15.8
LAUTECH	67(57.7)	62(53.9)	61(53.1)	66(56.9)	63(55.3)	13.3
Total	**175(36.9)**	**187(39.3**)	**163(34.2)**	**214(45.0)**	**228(48.0)**	**48**

The figure in bracket are in percentages and the figure outside are frequencies

Table-9 (b). Descriptive statistics Mean Adequacy Scores for Safety and Security (MASS) and Building Services (MASBs).

Mean adequacy scores	Frequency	Minimum	Maximum	Mean	Std. deviation	Total mean adequacy attributes
(i) Mean adequacy score for *safety and security*	469	1.00	5.00	3.1493	.81654	1477.0
(ii)Mean adequacy scores for studio building services	472	1.00	5.00	3.2357	.83525	1527.3

Interestingly it is noteworthy to articulate that most of the fire safety equipment appeared not to be in use since their installation. They needed to be tested from time to time to ensure their readiness in case of emergency.

The results presented in Table-10 and Figure-7 show that only a few respondents 114(24.3%) disclosed that the security in their design studio was very adequate, some 203(43.3%) disclosed that it was fairly adequate, while the rest respondents152 (32.4%) disclosed it as very inadequate and inadequate.

In other words, out of 469 respondents, if only 114(24.3%) described the safety and security as very adequate and 152(32.4%) as inadequate; it means that there were issues of security and safety to be attended to in these selected schools. This may invariably be affecting others schools that are yet not investigated.

Table-10. Safety and security requirements: Mean adequacy scores for safety and security requirements in four (4) selected architectural design studio.

Class interval (Mean Adequacy scores for Safety and Security Requirements-MASSS)	**Frequency**
1-2	45(9.6)
2.20-2.60	107(22.8)
2.80-3.80	203(43.3)
4-5	114(24.3)
Total	469(100)

The figure in bracket are in percentages and the figure outside are frequencies

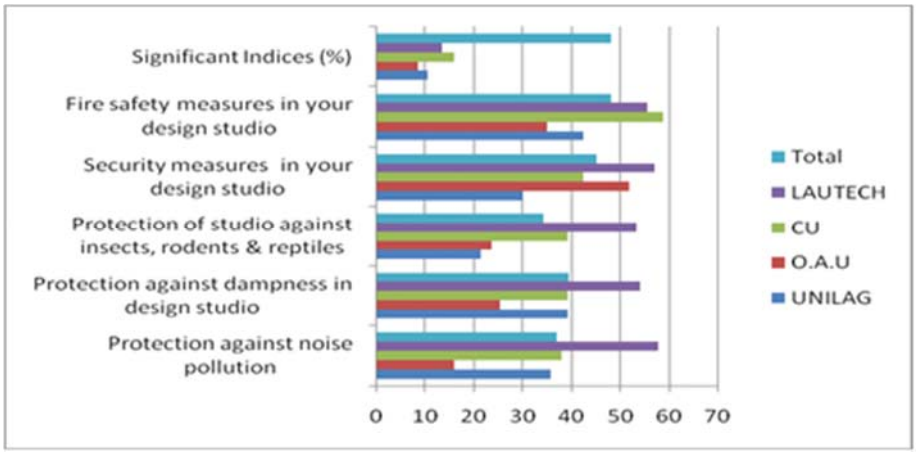

Figure-7. Showing safety and security requirement for the quality of design studio.

4.5.1 Implication on the respondents safety and security in the design studio environment

The safety and security items considered on the questionnaires were (i) protection against noise pollution from within and outside studio environments (ii) protection against dampness in the design studio i.e. of drawing papers, tables equipment, instruments, walls and floor surfaces, (iii) protection against insects, rodents and reptiles(iv) security and (v) fire safety measures. These factors are very important in order to safe and protect lives and properties; the design studio needs to be guarded against attacks from insects, weather and other hazardous influences. Another aspect is that a drawing in progress by students and the completed ones should be able to enjoy absolute safety and security even when the user is not there. Table-11 presents the nexus of mean adequacy scores for ventilation, safety and security, and privacy requirements for the four (4) selected architectural design studio learning environment. Considering the three (3) mean adequacy scores for MASV (ventilation), MASSS (safety and security), and MASP (privacy), the mean scores were

3.4016, 3.1493, and 3.0740 respectively. The results show that, the mean adequacy scores for ventilation (1595.4) was most significant, while the mean adequacy scores for privacy was the least.

In the order of scale of preference, if these schools were to have a shift in their 'modus operandi' of their design studio environment, that is, the studio workspace, then urgent attention needs to be given to *privacy* requirements of the design studio work space and environment.

Table-11. Nexus of mean adequacy scores for ventilation, safety and security, and privacy requirements for the four (4) selected architectural design studio learning environment.

Measurement	**Mean adequacy score for ventilation requirement** (MASV)	**Mean adequacy score for safety and security requirement** (MASSS)	**Mean adequacy score for privacy requirements for design studio environment** (MASP)
Respondents Frequency	469	469	473
Mean	3.4016	3.1493	3.0740
Median	3.3333	3.0000	3.0000
Mode	4.00	3.00	4.00
Std. Deviation	.95412	.81654	1.24738
Variance	.910	.667	1.556
Range	4.00	4.00	4.00
Total Mean Adequacy (TMAS)Scores	1595.4	1477.0	1454.0

The implication pedagogic implication is that, in the four (4) selected architectural design studios, privacy was given an insignificant place for smooth operation of both sets of respondents (students and staffs) across these schools. It means that the original purpose of architectural design studio as adorable spaces has been on a serious decline. This could point to emergent issues (Adeyemi, 1996; 2000) on many reasons why most architectural design studios have been deserted: (i) there is little point in coming into the studios-when you do few people are there any way (ii) marks are based on arbitrary judgement made by juries more often than not ignorant of the students criteria and approach (iii) the best work is done at alone at home (or hostel), in spite of studio instructors advice e.t.c. Consequently, the attitudes imbibed in the studio are those that young graduates take to the profession (Salama, 2006).

As pointed out long ago (Adeyemi, 1996; 2000) that deserted studio has become an embarrassing development; Ritter pointed out that 'the deserted studios of many famous seat of architectural learning are not to be taken as failure of the project approach; they are signs of inferior educational atmosphere of the place'.

In searching for solution after applying so many palliatives, architectural education scholars in this line of epistemological development have come to conclusion that the educational atmosphere needs enrichment. According to some psychologists (Adediran *et al.*, 2003), who opined that in certain environment, if one is forced to interact with others more than desired, privacy would be a key consideration. Table-12 presents the mean adequacy scores for privacy requirements (MASP) for the four (4) selected architectural design studio environment. The environment psychologists suggested that environment settings affect social motivation through several mechanisms; the principle, policy and implementation strategies of using a particular environment.

Table-12. Mean Adequacy scores for privacy requirements (MASP) for the four (4) selected architectural design studio environment.

Class interval (of mean adequacy scores for privacy requirements-MASP)	**Frequency**
1-2	162(34.2)
3.00-4.00	252(53.3)
4.10-5.00	59(12.5)
Total	473(100)

The figure in bracket are in percentages and the figure outside are frequencies

4.5.2 Mean Adequacy Scores for Safety and Security (MASS) and Building Services (MASBs)

By services, it means basic and functional services such as water supply, energy supply (electricity, gas and other sources of energy), sewage disposal, refuse disposal and fire services. While the security and safety services are included, both the safety-security and building services are interrelated.

From the respondents' view, the result showed that the adequacy scores for building services was higher than that of safety and security. It implies that though the building services were available but not safely secured as

expected. From the on- site investigation and observation, most of the design studios were not properly secured in terms of safekeeping of equipment, drawings, and tools. Fire services were not installed and where installed only few knows how to operate it, while others were not tested overtime to ensure their workability.

The Nine items auxiliary facilities considered for the adequacy of architectural design studio environment are provisions of (i) Drawing materials shop near studio (ii) Communal facilities/activities between studio and neighbourhoods (iii) Digital Software and Hardware Facilities (iv) Playground for Students' Recreation (v) Road Network and Parking Spaces near the Design Studio (vi) Open Spaces/ Green Areas. (vii) Medical and Health Care Services (viii) Finishes on walls, floors and Ceilings (ix) Transport Service between Studio and Hostels.

As presented in Table-13, most respondents 262(69.7%) signified very high degree of Mean Adequacy Scores for Provisions of auxiliary facilities while a few 114 (30.4%) signified low adequacy.

Table-13. Mean Adequacy Score for Auxiliary Facilities (MAAF).

Mean adequacy scores for auxiliary facilities	**Frequency** (%)
1-2	114(30.4)
3-5	262(69.7)
Total	376(100.0)

The figure in bracket are in percentages and the figure outside are frequencies

4.6 Parametric predictors of design studio environment workspaces

According to the factor analysis carried out in this study, when the learning environment was regressed with other factors like pedagogy and studio culture, the adequacy parameters were crystallized in the layers of (1) Mean Score for Ventilation Requirement (MSVR), (2) Mean Adequacy Scores for Lighting Requirement (MASLR), (3) Mean Adequacy Score for Safety, Privacy and Security Requirement(MASPR), (4) Mean Adequacy scores for Studio Building Services (MASBS), (5) Mean Adequacy Score for Auxiliary Facilities Requirement (MASAFR). In this analysis, the Standard Beta Value, Standard Error, df, F-Value and Significant (P-value) values of the adequacy parameters were obtained as presented in Table 4.

5. PEDAGOGIC IMPLICATIONS AND PROPOSALS FOR DESIGN STUDIO WORKSPACE

The implication of the five contextual design studio workspace parameters can be summarized in term of pedagogic proposal as follows:

- Design Studio WorkSpace: The general design studio space required for learning was very adequate. But the 13.7 % inadequacy can be improved upon to meet up with the benchmarks as required by accreditation agents and sustainable requirements of architectural design studio, Al-Hassan (2009). This is because the aspect of space adequacy is one of the determinant factors considered for accreditation of schools.

- The effective lighting on the drawing Boards: on the drawing board was not given good attention and care. Such design studios were under the influence of diffused light, obstacles near the windows etc.; and also the maintenance, glass, and bar (MGB) factors. Since the maintenance factor measures the degree of dirtiness or cleanliness of the window pane through which daylight admittance occurred, the glass factor specifies the glazing types in use aside clear glass, and the bar factors registered parametric measures on framing types involved which may either be too bulky or slender in the face of daylight illuminance. In essence, for these schools affected, the MGB variables should be re-designed in accordance to the best practice (designer's specified standards), therefore, during studio work hours, users (respondents) may find it difficult to see clearly the details of work on the drawing tables.

- Ventilation and Design Studio Thermodynamics**:** The affected schools and other stakeholders need to consider the issues of sustainable design studio in terms of energy efficiency measure, installations and passive designs. Also, in the role definition and programme implementation schedule of the designers, stakeholders, education service managers and proprietors of schools, there is a major need to priotize the adequacy of the number of design studio spaces (**Table 3**) in line with requirements as specified by the concerned accreditation bodies- for the thermal comfort characteristics of the work space. This is to prevent deserted studio syndrome that may results from uneasiness, poor productivity and boredom due to over crowdedness with low level of thermal comfort.

- Safety, Security and Privacy: the stakeholders in public and private citadels architecture is that, the issues of safety, security and privacy should be given optimum attention. Attention should also be paid to protection of studio against insects, rodents and reptiles, the least index 163(34.2%); for they can easily destroy valuable items worth millions of naira, and in most cases, difficult to install and if lost more difficult to replace. More so, lockers, safe and wardrobes need to be provided to keep drawings and equipment in the studio and the organization of design space for privacy should be prioritize alongside the general workspaces.

- Auxiliary Facilities: although there were good provisions for auxiliary facilities. This means that the selected design studios have an appreciable accessibility to auxiliary facilities designated for design studio use. These facilities enhance the

students' performance in the studio; it helps the respondents to have a good focus, undisturbed rate of work, speedy achievement, work satisfaction, time control and management, and good efficiency. Therefore, more relevant auxiliary facilities should be installed in some of the studios with lower adequate indices.

- Illuminance Requirements: for workspaces of architecture, engineering and other allied professional training in schools, information for evidence-based conclusion needs to formulate specific improvement measures on the illuminance level of a learning space, especially where safety precautions has to be observed (i.e. engineering workspace or workshop). In this scenario, "Illuminance" is recommended as an essential parameter to be measured in
  a lighting assessment. It is needed to quantify the amount of light falling on a unit area of the work surface (e.g. design
  of engineering workshop and its measurement unit is "lux (lx)". It is used to evaluate the adequacy of lighting for seeing an object. Illuminance is measured by a luxmeter, which is a handy instrument with a sensor. In general, lux meters conforming to internationally recognized specifications (OSHLD, 2008) such as BS 667:2005, DIN 5032-7:1985 or CIE Publication No. 69 (1987), should be used. There should be regular calibration, typically once a year, to ensure accurate measurement.

6. CONCLUSIONS

This paper discusses "design studio space as a milieu of order, organized climate social environment for knowledge creation, transfer and sharing. This work established five major key adequacy parameters, representing the architectural design studio workspaces in the four (4) selected schools. Also the perceptual Indices to measure adequacy dimensions were highlighted to create an operational design studio workspace spectrum on the matters of strength, weakness, opportunities, and threat of these learning-working environment dimensions. Based on these adequacy parameters, five contextual learning-meaning can be deduced: first, design studio spaces need to be given adequate attention in the schools of architecture in order to enshrine best practices within school and outside school-meeting accreditation and client-users' requirements; second, it is not sufficient to train the students in just gaining skills. The instructor is the key factor in the studio in fostering creativity by training students to be pro-active in the intelligent ways of integrating daylighting into architectural forms and built environment; the third key factor was the instructors' role in the emphasis of the students' knowledge construction in the maximization of natural energies and minimization of artificial energy, with specific reference to tropical design factors of natural ventilation and lighting. Fourth, the installation of equipment and training of students and staff on how to use the ultra-modern fire and safety equipment in the design studio need urgent attention in most schools today. Lastly, another consideration is the auxiliary facilities needed to be supportive facilities to enhance the students' performance in the studio; it helps them to have a good focus, undisturbed rate of work, speedy achievement, work satisfaction, time control and management, and good efficiency. Finally, this paper highlighted grey areas of adequacy that the selected schools had not adequately addressed. The paper suggests the consistent review of the studio design spaces by the accreditation boards and universal standard for the training of architects.

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