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The Impact of Educational Technology Tools in Architectural Education in Nigeria

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ABSTRACT
This study examines the impact of educational technology tools some of which include; Computers, mobile devices, smartboards, software, cloud computing, 3D printing and virtual facilities. It was motivated by a dearth of empirical studies on the impact of information technology tools in relation to performance of users in schools of architecture in Nigeria. Data was elicited through interviews, structured questionnaires and students' records. To analyze the data obtained, inferential (ANOVA) and descriptive statistical tools were employed. Significant relationship between the performance of students of Architecture and the inclusion of educational technology tools in selected study areas were examined. The Findings from the study show that the inclusion of technology tools in architectural education in Nigerian schools of architecture has a significant effect on the performance of students in architectural design projects. The paper suggests that schools of architecture in Nigeria should encourage the inclusion of technology tools in architectural education. The use of technology tools in architecture should not be seen as just a technical skill, but rather a way of thinking for the architecture student. This implies that, the continuous use of technology tools in teaching and learning enhances creativity and design output.

Keywords: *Architectural education, Impact, Performance, Technology tools.*

1 INTRODUCTION

The profession of architecture is one of the oldest because it is related to the provision of designed environment and as such one of the fundamental variable to the provision of architectural education is design (Tavsan, Tavsan, & Sonmez, 2015). Architectural education is crucial towards the social and economic development of any given society (Charalambous & Christou, 2016). The challenges of Architectural education are multifaceted and some of these challenges include consumer (clients) increased power and expectations due to globalization as well as increased standardization of the industry (Charalambous & Christou, 2016). These amongst others have posed more pressure on the profession towards finding creative solution to the problems and challenges that continuously emerge. Similarly, there is a continuous emergence of cutting -edge technology towards increasing the learning capabilities as well as the practice of professional architects in the field. These technologies in many cases provide improved quality of performance of the design process as well as design outputs.

Architecture is asserted to be related to many other disciplines and as such has given increased social responsibility to the profession of architecture. Architectural education worldwide is multi-disciplinary in nature and it often involves serious practical exposures. Hence, there is a need to enhance the quality of education in terms of learning, teaching and working (Adegbile, 2010). The perception of art delivered by architectural education is in some way, constricted and as a result, emphasizes individual creativeness, and ability to solve problems (Kangasoja, Hirvonen & Mäntysalo, 2010).Thus, the profession requires people who practice it to be self-confident, sociable and naturally cultured, forward looking so as to be able to proffer solution to the needs of the populace when it comes to design (Yasar & Kalfa, 2015).

The primary place for the development of these aforementioned skills for the trainee architect is the academic institution and thus the development of the confidence and educational knowhow relies on how effective the students are exposed to the technological advancement especially IT. This is why architectural institutes, associations, educators, and relevant stakeholders are advocating a change in the system of architectural education, recommending an inclusion of more recent educational tools driven by technological advancement with the aim of meeting up with the rest of the International community. There are also calls for a change (or at least, a reassessment) of existing curriculum of architectural programs to better reflect the realities of our dynamic society (Olawale, 2014).

There appear to be a gap in architectural education which limits learning and performance. Design education and digital technology education continue to be seen as separate entities in relation to learning (Shelby, 2016). Technology tools ideally, should enhance design education by providing specific ways of designing with educational technology tools...not just technical skill on how to use software or operate machines, but how to design digitally. Nick and Doyle (2016) explained that for

effective performance, architectural education should provide a foundation of deep learning which entails knowledge of fundamental principles, structures and strategies. These skills and strategies should be able to be applied to new architectural problems and contexts different from the ones where learning originally occurred (Shelby, 2016).

Though, students of Architecture in Nigeria had long been using CADD, it is yet to be accepted as an official tool (Musa, 2002). There exist a school of thought which believes that the utilization of IT tools limits the creative abilities of students of architecture. As such, this study is poised to determine if there is any correlation between student performance and the adoption of educational technology tools.Architectural education in Nigerian universities face several challenges that have made it difficult to positively compete with counterparts across the globe. Aderonmu (2011) posits that these challenges include inadequate funding, overpopulation of students, and inadequate web-based facilities.

Selwyn (2011) describes educational technologies as electronic technologies used for information storage and retrieval. Development is in part, determined by the ability to set up a synergistic interaction between technological innovation and human values. However, there are still debates in architectural institutions in Nigeria whether or not CAD should be adopted as the official means of design, relegating the concept of manual drafting. Okpoechi (2003) in her submission further posited that limited financial capacity of students, the challenge of inconsistent electricity supply, device storage collapse and mechanical failure constitute major limitations to actualizing the adoption of CADD. However, there exist the possibility of utilization of alternative and sustainable sources of energy such as photovoltaic cells with the abundant solar radiation in Nigeria.

The knowledge and utilization of CADD in teaching and learning by architecture students is important because Architecture has moved beyond 2-dimensional drafting to include three and four dimensions. For example, building information modelling is emerging as a novel compelling technology. This is because, building information modelling provides professionals in the areas of engineering, architecture, and construction with the ability to design plan, manage and construct buildings more efficiently (Wix, 2009). Building Information Modelling simulates a building process and even adds an extra function of cost estimating. BIM provides the foundation for a collaborative design process (Adeli, 2009). Professionals in building process could work on one integrated model and can share and access information regarding the project at any time. As such, BIM provides a medium towards integrated project delivery.

While CADD technologies have become common place in architectural practice as tools for efficiency and production, the introduction of CADD especially in early architectural curricula has been met with anxiety. Some believe adopting CADD will invariably lead to reduced creative performance (Pallasma, 1996). However, Nick (2014) in his submission explained that if the learning process is modified sufficiently by introducing soft learning skills in digital design, CADD and other digital devices will enhance creativity and overall performance. Shelby and Senske (2016) suggest that CADD technologies impact performance and so they extend beyond pedagogical and semantic arguments.

In adopting the inclusion of technology tools in architectural education, visual plagiarism has been identified as a negative impact that may arise. But even detecting plagiarism in visual representations is not easy to do (Barret, 2013). When comparing forms, for instance, it is difficult for educators to establish that one form bears enough resemblance to another to determine that plagiarism has taken place. Also, architecture emphasizes team-based projects and collaborative learning which makes the distinction between plagiarism and sharing even more blurring (Walker, 2009). Barret (2013) suggests that to limit visual plagiarism, educators and architecture faculty must see the necessity in requiring students to cite sources even in design. Students need to be educated about academic integrity in art and the importance of citing visual sources in design just as much as text-based citations. Avoiding generic design brief for architectural projects will also limit tendency to plagiarise. When students are required to develop projects with unique data, plot size, purpose, scope and other design considerations, plagiarism becomes an unreasonable option for them (Alice &Smith, 2015).

2 METHODOLOGY

To assess the impact of educational technology tools in architectural education in Nigeria, a purposive sampling technique was used to select Nigerian institutions with a department of architecture.

Structured questionnaires were used as the primary instrument of data collection with the aim of collecting information about inclusion of educational technology tools as it impacts on the performance of students in these institutions, courses offered, the challenges of architectural education faced by the institutions, level of awareness, knowledge and student's ability base on some of these technology tools and the benefits of using educational technology tools in architectural education especially computer aided design programs and building information modelling. More importantly, the questionnaire comprised questions on level of awareness, knowledge and abilities of respondents as relates to educational technology tools. Respondents were also

required to rate the adequacy of technology tools currently available in institutions on a likert scale of 1-5, identify the tools they would rather see integrated in their institutions, and indicate the perceived benefits of having these educational technology tools.

Questionnaires were sent out to three institutions including the Federal university of technology Minna, Niger state, Ahmadu Bello university, zaria, and Abubakar Tafawa Balewa university, Bauchi. Of the 94 questionnaires issued, 86 were returned valid, representing a 91% response rate.

To analyse the data obtained, descriptive and inferential statistical methods were employed. Descriptive statistics involving frequencies, tables and charts were used mainly to present data relating to research questions raised. Since evidence in literature (Olotuah, 2000 and Adeli, 2009) suggests that educational technology tools has an effect on the performance of students of architecture, this paper employed analysis of variance (ANOVA) as an inferential statistical tool with the aim of testing hypothesis. The analysis sort to establish whether a significant relationship exists between performance of students of architecture and the inclusion of educational technology tools. Scores of students in Architectural design (a manual drafting course taken through 4 years) were obtained and compared with scores of the same students in Computer Aided Design (a course which employs educational technology tools) over a period of five years. These scores were further analyzed to determine where students performed better. The result of the analysis is presented in the subsequent section of this paper.

3 RESULTS AND DISCUSSION

The statistical test of significance carried out provides substantial empirical evidence for the idea of educational technology inclusion in architectural education. The purpose of this analysis was to evaluate the impact of inclusion of educational technology tools on architectural education by investigating if educational technology tools have a significant influence on the performance of students of architecture.

The hypothesis; H_a**1 (**the inclusion of educational technology tools in architectural education has a significant impact on the performance of students of architecture) will be tested to achieve this.

Participants and measures–
The scores of a total of 348 students of Architecture were obtained and recorded. These scores were obtained for academic sessions taking a two-year interval from 2012 to 2016. Students who participated were required to have taken both architectural design and computer aided design courses for every particular academic year.

Statistical procedures–
To test the hypothesis that the inclusion of educational technology tools in architectural education has a significant effect on the performance of students of architecture, analysis of variance statistical test of significance was used with student performance as the dependent variable and courses offered as the predictor. Determining the performance of students was dependent on having educational technology tools included in architectural design or having students design without any digital aid. The scores of students were inputed under for samples for each session.

Results–
With reference to Table 1, $p < 0.0001$, $\alpha = 0.05$, the ANOVA analysis was highly significant. The p value (probability value) used to determine statistical significance in any hypothesis test, was much lower than 0.05 which usually signifies a significant difference. We therefore accept the hypothesis H_a**1** and conclude that the analysis of variance test confirmed that participants who offered Computer Aided Design courses where educational technology tools formed the basis of learning had better performance than in architectural design courses which did not employ any technology tool.

Table 1:ANOVA test of significance explaining the independent and dependent variables
Source : Researcher's field report, 2017

From the Tukey HSD (honest significant difference) test, the relationship between independent variables and dependent variables can be explored further. The test showed that there was significant difference between values from samples M1 vs M2 and M3 vs M4 (P<0.01) where M1 and M3 represents scores of students in architectural design for 300l and 500l while M2 and M4 represent scores of students in CADD.

ANOVA Summary - Independent Samples k=4

Source	Sum of Squares	Df	Mean Square	F	P (sig)
Regression	3896.8646	3	1298.9549	1	<.0001
Error	25347.1944	23	108.7862		
Total	29244.0591	23			

However, results obtained from sample M1 when compared with M3 did not significantly differ and hence the relation was nonsignificant. There was a significant

difference in sample M2 vs M4. This showed that students performed better in the same computer aided design course as they progressed to higher academic levels. This probably reflected the fact that students got more familiar with IT tools and were more skilled at using these digital devices over the years. This led to increased performance. Results over a five year period were consistent as shown by the standard deviations; 11.2800, 9.6532, 11.1317 and F-value from the Anova summary; 9.51, 4.97, 11.94. The p-value was also consistent with significant difference observed for every session.

Table 2 and Figure 1 indicate that Building Information Modelling and 3D printing were some of the most compelling tools that respondents preferred to have included in mainstream architectural education systems. Others are; CAD, computers and handheld devices. Web-based learning nets and open content were the list options, probably because respondents were not familiar with these concepts as they are fairly recent.

Table 2: Educational Technology tools respondents would rather see integrated

OPTIONS	**FREQUENCY**	**PERCENTAGE (%)**
Computers	14	16%
Smart boards (Interactive multimedia)	06	07%
3D printing	16	18%
Handheld devices	08	9%
Computer Aided Design Programs (CAD)	10	11%
Building Information Modelling (BIM)	18	21%
Social media and Gamification	08	09%
Web-based learning nets	04	4%
Open content	02	2%
Total	86	100%

Source : Researcher's field report, 2017

From the analysis of the responses given by participants in the survey listed in table 3, a number of benefits of inclusion of educational technology tools in architectural education in the study area were identified. Findings from the table shows that, the ability of educational technology tools to reduce time and effort expended in design and the degree of accuracy in design production and presentation where some of the most important benefits identified by respondents. Due to the fact educational facilities in most institutions in the study area did not have the advantage of a collaborative design process, the benefit of working on one integrated project offered by technology tools received low ratings. Respondents however, were of the consensus that educational technology tools were already quite beneficial to them and better implementation/further inclusion of more technology tools would be of even greater good.

Table 3: Perceived benefits of inclusion of educational technology tools in architectural education

Benefits	Frequency	Percentage (%)
Easier and quicker access to information	16	14%
Reduced time and effort in design	07	32%
Enhanced accuracy in design production and presentation	06	20%
Ease of modification and reproduction of drawings	24	15%
Possibility to work on one integrated project with other professionals	35	7%
Ability to create three dimensional virtual environments	03	12%

Source : Researcher's field report, 2017

4 CONCLUSION

This study has examined the impact of educational technology tools on architectural education in Nigeria. Findings show an increased performance when technology tools have been utilized in digital design or in developing architecture. This proves that inclusion of technology tools in architectural education has a positive impact on performance. However, to achieve steady and even greater performance, architectural education must also recognize and deliver more than technical proficiency. Students need to be able to work creatively and efficiently with computers, software, digital fabrication machines and other devices. Students need to be comfortable utilizing these tools to ensure they can effectively manipulate them for greater problem solving. This is only possible when they are constantly exposed to technology tools.

This paper suggests that schools of architecture in Nigeria should encourage the inclusion of IT tools in architectural education. Their utilization should constitute a requirement, a way of thinking for the trainee architect not just technical ability.

A correlation of students result in CADD and architectural design indicates improved performance as shown in this study. Consequently, the use of technology tools in other courses should also be encouraged as it can produce similar results. This should not be limited to software alone. Sketch up pro and Think pads are digital tools that can increase performance in freehand sketching and perspective drawing. Other digital devices such as multimedia interactive tools, virtual facilities and 3d printing can enhance students practical experience, giving them a more realistic understanding of design, construction, construction materials and project management.

Design plagiarism does constitute a negative in utilization of IT tools in architectural education. This paper suggests that educators can develop custom and specialized design

briefs. This will make it cumbersome or even illogical for students to consider plagiarising designs. It will also force students to master/control technology, using it in a more creative and less repetitive and derivative way. References or citations for design work, though unorthodox, should be a requirement.

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