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Research Article

A GENDER ASSESSMENT STUDY ON STUDENTS' PERCEPTION OF BIM AND CAD IN THE FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA NIGERIA

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Abstract

Computer-aided design software used by professionals in the built industry has revolutionized what is regarded as design for these individuals, among which students are not excluded. Design using this medium has again been developed further with the introduction of BIM (Building Information Modelling). This study is aimed at investigating the perception of BIM and CAD software among male and female students of Architecture in the Federal University of Technology Minna, Nigeria. The research method used for this study was quantitative in nature, where data was obtained from probability sampling technique, specifically the stratified sampling method. Data was collected with the use of an open-ended interview, where by male and female architecture students in Federal University of Technology were interviewed. Findings showed that male students found BIM software easier to use than female students in the department of architecture. Furthermore, most students learnt to use both BIM and CAD software either by themselves or from their colleagues. The study makes suggestions for department of architecture and recommends the provision of active means through which all students can benefit from all that BIM software has to offer through the provision of adequate teaching in the use of these applications.

Keywords: Architectural education, BIM, CAD, Gender, Students' Perception.

INTRODUCTION

As computer advancements began to emerge in the early 80's, architects commenced the use of programmes such as Computer Aided Design (CAD) for their drawings which were previously drafted manually (Levy, 2012). As a result of this, it led to the emergence of various design software to be used by professionals in the built industry, which completely transformed the dynamics of what design looked like. According to (Waterhouse, 2013), he stated that Building Information Modelling (BIM)is advancement from other drafting tools used in past time, by adopting the 3D model as an interactive database containing the required information of a proposed design (Kivits and Furneaux, 2013). Opined that, BIM has the ability to drive sustainability in design. In the construction industry, the continuous development of the application of BIM has garnered series of research in aspects of this application that relate to its technology and management (Zou *et al.*). Students, particularly architecture students in the AEC (Architectural, Engineering and construction) field, are expected to be more familiar with the BIM application as opposed to other professions in the built industry. Although anticipated, this is not the case. AEC student's opinion on BIM implementation or industry practice has not been fully exploited by existing managerial studies (Maina, 2018b). Highlighted, in Nigeria students these days have become more aware and proficient with the use of CAD software such as AutoCAD and Google Sketch Up compared to the use of BIM software like Autodesk Revit. After learning that some studies have explored the use of CAD and BIM in professional practice, (Maina, 2018b) discovered that few studies attempt to identify advantages from the student perspective towards improving learning and pedagogy.

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The aim of this study which is gender based, is to investigate students usability of BIM and CAD software in the Department of Architecture, Federal University of Technology Minna, Nigeria.

LITERATURE REVIEW

Over the past 30 years, there has been a shift in drafting mediums, where manual drafting with the drawing board has been replaced with two-dimensional (2D) CAD. However, this change has observed little differences in the drawing formats (Shelbourn *et al.,* 2017; Ramilo *et al.,* 2014) expressed that CAD software encompass non-parametric tools that enable drafting, visualization and documentation. Furthermore, (Czmoch and Pekala, 2014), state that this application provides drafting techniques that are automated. CAD programmes like Auto CAD and Sketch Up which are used for 2D drafting, were developed from techniques of manual drafting (Maina, 2018b), however, Revit, which is a BIM software, is able to simulate 3D models of buildings with the aid of parametric building components that imitate real life scenarios (Ramilo and Embi, 2014).

BIM Applications

BIM has often been interchanged with CAD, the difference however is that where CAD programmes were developed to mimic hand drafting and make it easier, BIM was developed to simulate or imitate 3D building models that encapsulates all information about the project. This encompasses within a single database, elements involved in construction stages. It is targeted to be used in several stages and dimensions; 3D being a model or extension of the 2D design, 4D used to show the time of the project dividing schedules into phases, 5D involving cost estimating, 6D dealing with the sustainability of the project and & 7D which involves the post occupancy

evaluation and facilities management (Czmoch and Pekala, 2014). BIM has been instrumental in making the construction industry evolve from 2D information systems to 3D information systems. This change has further evolved into 5D integrating digital descriptions of building elements, and time required and cost of projects. The construction industry is constantly trying to achieve coordination among building professionals and the introduction of BIM related software has aided that (Snehal *et al.,* 2017). In 2015, a study carried out by (Ashworth, 2015) showed that there was a large interest in BIM among stakeholders responsible for property portfolios. The research showed that about 32% of stakeholders in Switzerland already had experience with BIM, and is interested in using it for facilities management of their properties. Most of the stakeholders were eager to see the introduction of policies and guidelines regarding the use of BIM for facilities management. Some of the benefits they believe they will achieve through the use of BIM include - cost savings and lifecycle costing, increase in operational efficiency, reduction in carbon emissions and energy savings, business continuity and service operation and others. However there were some barriers they also mentioned to its use, which include a lack of expertise, costs, lack of demand from clients, and its relevance to project works. But they believe that if the demand for its use increases from clients, it will go a long way in eliminating other barriers (Maina, 2018a). Also states that the use of BIM by architects is because of its benefits in efficiency, presentation and team work (Brown *et al.,* 2019). states that the use of BIM has been aided by significant discoveries in the IT world having advantages such as speed, quality, ease of use and enhanced collaborations.

BIM Education

Succar *et al.,* 2012 believed that BIM education involves spreading basic awareness about its risks and benefits and also ensuring specialist knowledge and skills in BIM. They believe BIM education facilitates collaboration of project participants across all phases of the building life cycle and it will be the main method to spread advances in technology enabled design. (Botchway *et al.,* 2015) stated BIM should be taught to people within the industry and within academia for effectiveness and that BIM education is more individualistic as opposed organizational and do not think this aspect is a priority as most workshops focus on standards, legal implications and guidelines. In the industrial sector it is believed that BIM should be taught to employees of small organizations with low training budgets, employees of single disciplinary organizations, team managers and senior managers. Furthermore, in the academia it should also be taught to students of universities who are yet to embrace BIM education, lecturers within universities, deans, heads of schools and directors and accreditation boards tasked with reviewing and accrediting universities. Succar *et al.,* 2012 also further expressed that if all this is done, the knowledge and use of BIM will be greatly increased. They however feel that the introduction of BIM to universities is likely to encounter some resistance because of the following;

- The difficulty of introducing new topics into a crowded curriculum
- Unfamiliarity of lecturers with BIM
- Reluctance of lecturers to alter already established teaching methods
- Inability to bridge the gap between departments and offer collaborative courses.

There are several ongoing debates about the introduction of BIM in schools of Architecture in the Nigeria, but the fact remains that CAD and BIM tools have become indispensable to contemporary practice in design and construction (Maina, 2018a) and more research is currently done on the most effective ways to equip students with the necessary knowledge. (Maina, 2018b) expressed his views by stating that in Nigeria, students are not as proficient in BIM software when compared to other CAD related software. The use of BIM in Nigerian schools of architecture for education, presents itself with some barriers that militate its effective and efficient use, such as the difficulty in adopting the software by older professionals, inadequate supply of skilled staff to meet specialized skills, high cost of software and training, lack of flexibility, the need for cultural changes, IT illiteracy, legal uncertainties, and lack of practical standard guidelines. Brown *et al.,* 2008 states that, BIM application is in need of development in areas of technology, collaboration and appropriate guidelines. All these can serve as inhibitors to the much needed BIM education in schools of Architecture.

Zou *et al.,* opined that due to lack of sufficient study on AEC (Architecture, Engineering and Construction) a research was carried out overall in BIM perception of students. This was done in order to determine how students' disciplines, experience and gender is affected by BIM practice, making further comparisons between AEC students and professionals in this industry. Perceptions towards BIM implementation from student's point of view holistically comprises of risks, challenges, benefits, and critical factors in the implementation of BIM according to multiple prior studies.

METHODOLOGY

The research method adopted for this study is quantitative in nature, which collects data from given samples in order to make deductions about a population, and study attitudes and opinions (Creswell, 2012). From studies carried out to investigate student's perception on the use of BIM and CAD software based on gender, quantitative data was gathered and analysed to obtain tangible findings which were then interpreted to gain insight on the subject matter. The study area is the department of architecture, Federal University of Technology Minna, specifically architecture students from the third year to fifth year which are the sample size of this study. The quantitative data gotten through interviews conducted with the instrument, interview guide, included open-ended questions which were organized based on the aim of the study. Parameters to check for student's perception on BIM and CAD were gotten from studies by (Maina, 2018b), and (Zou *et al.*). Such parameters adopted for this study include, investigating the effect of sub-group factors such as gender and year of study on their perception of BIM and CAD software and also highlighting student's overall perception of the BIM software compared to non-BIM software. The sample for the study was selected based on probability sampling technique, specifically the stratified sampling method. The sample was selected based on the level of study from which five students were selected at random to be interviewed. In total, a number of 15 interviews were conducted, of which 5 each were from third, fourth and fifth year students respectively of the department of architecture, Federal University of Technology Minna,

Nigeria. Data collected from the respondents of the interview conducted were analysed using the statistical tool SPSS. Graphical charts were used to highlight and present the key results according to the parameters and variables measured for this study, as shown below.

RESULTS

Out of 15 students interviewed, about half of the respondents identified Revit as their most used software at 40.0%. The remaining 60% of the respondents however, either chose to merge the use of two different software, or the use of an entirely different software (Table 1 and Figure 1.).

Table 1. The percentage of responses based on most used software

Software	Frequency	Percent	Cumulative Percent
AutoCAD	2	13.3	13.3
SketchUp	2	13.3	26.7
Revit	6	40.0	66.7
AutoCAD and SketchUp	3	20.0	86.7
AutoCAD and Revit	2	13.3	100.0
Total	15	100.0	

(Author, 2021)

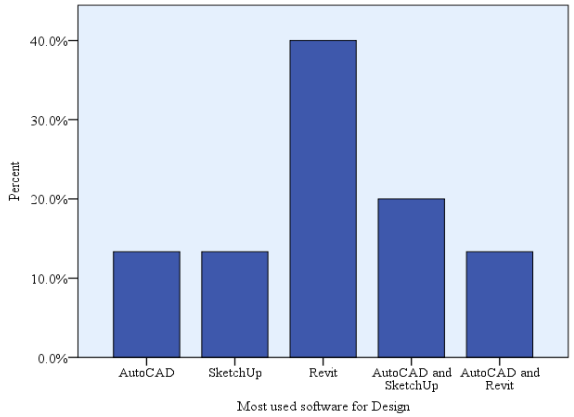


Figure 1. A histogram showing the percentages of the most used software (Author, 2021)

As shown in Table 2, the general overview of the responses from 33.3% of the students revealed that majority also considered Revit to be simple to use, about 5% lesser than this, 4 of these students were neutral in their response. At 6.7%, very few of the respondents thought the software was either difficult or very difficult to use.

Table 2. The percentage of responses based on the simplicity of Revit software

	Frequency	Percent	Cumulative Percent
Nil	3	20.0	20.0
Very Simple	1	6.7	26.7
Simple	5	33.3	60.0
Neutral	4	26.6	86.6
Difficult	1	6.7	93.3
Very Difficult	1	6.7	100.0
Total	15	100.0	

(Author, 2021)

Answering to the Likert scale, (in which 1 was very simple, 2-simple, 3-neutral. 4-difficult and 5-very difficult), the respondents rated the level of simplicity from their perspective. This data was then correlated against the gender of the respondents. Figure 2 shows that overall, Revit was the simplest to use, while Figure 3 shows that female respondents found Revit to be more difficult than their male counterparts.

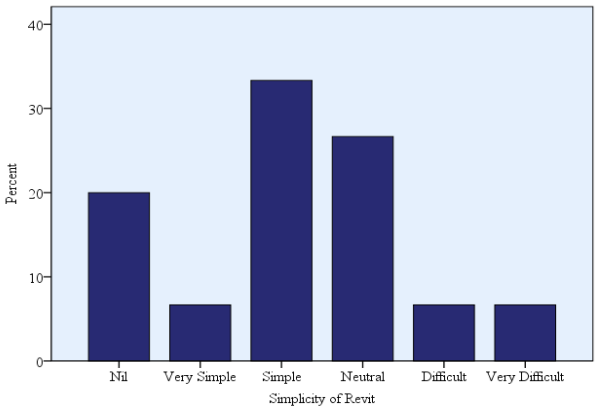


Figure 2. A histogram showing the percentages on the simplicity of Revit software (Author, 2021)

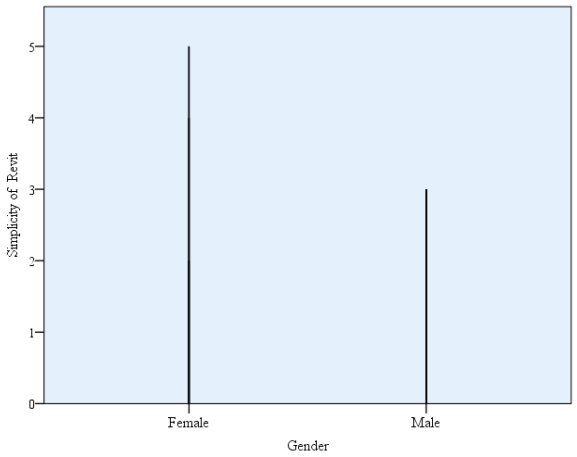
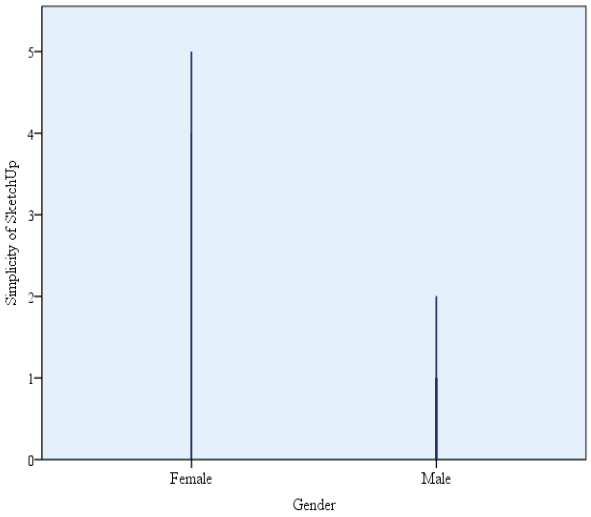


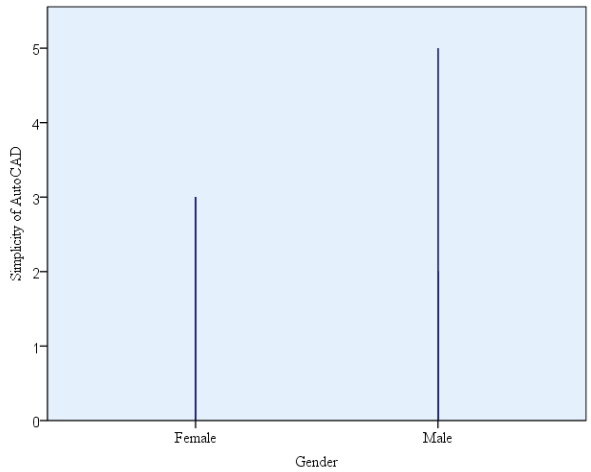
Figure 3. A histogram showing the simplicity of Revit software correlated with gender (Author, 2021)

A different 3D software, SketchUp, was sampled to infer whether there would be a change in the perception of Revit software. Using the same Likert scale, the same kind of result occurred where overall, female architecture students found the software more difficult than male students as shown in Figure 4. However, using the same Likert scale, this time, female students found the use of AutoCAD simpler than the male students as shown in Figure 5.



(Author, 2021)

Figure 4. A histogram showing the simplicity of SketchUp software correlated with gender



(Author, 2021)

Figure 5. A histogram showing the simplicity of AutoCAD software correlated with gender

Based on how students acquired the skill of using BIM software, majority of the respondents (33.3%) indicated that they were either self-taught or by the tutor of colleagues, with fewer mentioning that they learned to use BIM and CAD software from school (1%). This information is shown in Table 3 where Figure 6 illustrates this data in a histogram.

Table 3. Showing the percentage of responses based on how the respondents learned the BIM Software

	Frequency	Percent	Cumulative %
Nil	3	20.0	20.0
Self-taught	5	33.3	53.3
Self-taught and Colleagues	4	26.7	80.0
Self-taught and School	1	6.7	86.7
School	1	6.7	93.3
Colleagues and School	1	6.7	100.0
Total	15	100.0	

(Author, 2021)

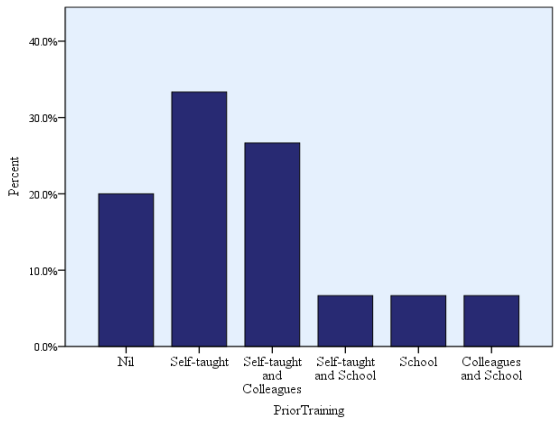
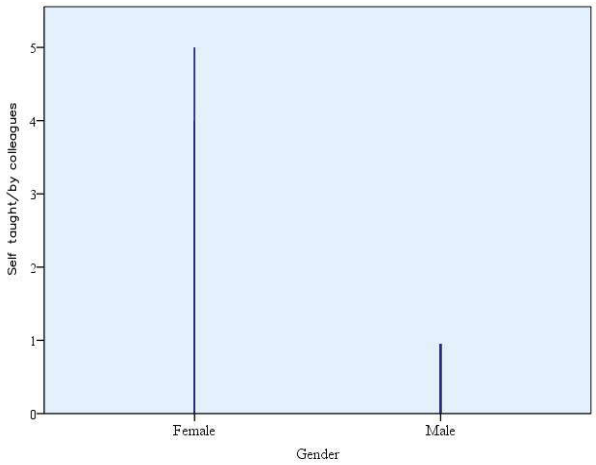


Figure 6. A histogram showing the means by which BIM and CAD software were learned.(Author, 2021)

Figure 7 on the other hand shows that the students who learnt the use of BIM/CAD software by either being self-taught or tutored by colleagues were female. Answering the question if the respondents believe that architecture students should have knowledge of BIM/CAD software, the result was unanimous. Table 4 shows the percentage of the responses. This should be a marker telling that there is a demand for the software by students.



(Author, 2021)

Figure 7. A histogram showing medium of learning BIM/CAD (self-taught/by colleagues) correlated with gender

Table 4. Showing the percentage of responses based on if they agreed that architecture students should have knowledge of the BIM/CAD software

	Frequency	Percent	Cumulative %
Yes	15	100.0	100.0

(Author, 2021)

DISCUSSION OF FINDINGS

Respondents highlighted their various views on BIM and CAD software, specifically the Revit software, and it was discovered that what they considered to be easy to use differed with respect to their gender. When comparing Autodesk Revit, Sketch Up and AutoCAD, it was discovered that female respondents generally found the use of 3D software more difficult than the 2D software such as AutoCAD, while male students found BIM software. The means by which majority of the respondents used to learn CAD and BIM software was either self-taught or through tutorials by their colleagues. Only about 20% of the total respondents mentioned that they learned BIM from school with, 60% going for self-taught or by tutorials from their colleagues. This highlights that there might be little or no incorporation of BIM software in the curriculum of the department of architecture. Despite this, most of the students expressed interest in knowledge about the use of BIM as they were unsure how this knowledge or lack thereof, would affect them professionally after graduation. As a result of this, the respondents were in the affirmative about taking a course on BIM in school if taught by their teachers; however, the students did not think BIM could be taught effectively in the school due to lack of infrastructure to cater to this.

Conclusion and recommendation

BIM software is a design tool that is used and appreciated in a vast number of professions, particularly in architecture as this software is an advancement of CAD. Despite its extensive use by various professionals, students are not excluded from its demand in the market. Therefore, it would be of great benefit to the students is the department of architecture incorporates the BIM software into their architectural education. Since BIM incorporates into one, designs in architecture, landscape, installation and cost estimates, knowledge of this will be beneficial as it allows for efficient changes to be made in 3D

modelling, and enhance creativity as indicated by the respondents from this study. The department also stands to gain an increased chance of perceived simplicity of BIM software, thereby making it more receptacle. This in turn will enhance educational output from architecture students in the Federal University of Technology Minna. It was also discovered in this study that female students perceived the use of BIM software different from the male students; this could perhaps be as a result of some social or psychological factors that should be worth exploring. The department of architecture should provide active means through which all students can benefit from all that BIM software has to offer. Furthermore, it should be taught in collaboration with other departments of the building industry as it will foster the transfer of knowledge and prepare students for the professional world.

Statement of competing interest: The authors have no competing interests.

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