EFFECT OF 3D BUILDING MODEL ON STUDENT ACADEMIC PERFORMANCE IN BUILDING TECHNOLOGY IN TECHNICAL COLLEGES IN NIGER STATE

BY

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CERTIFICATION

This is to certify that this project, effect of 3D CAD building model on student academic performance in building technology in government technical colleges in Niger state metropolis, carried out by Sadiq, Oluwabunmi Babatunde and submitted to Industrial Technology and Education Department Federal University of Technology Minna in partial fulfillment of the requirement for the award of Bachelor of Technology (B.TECH) in Industrial Technology and Education.

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APPROVAL PAGE

This project has been read and approved as meeting the requirement for the award of B.TECH Degree in Industrial and Technology Education of the Department of Industrial and Technology Education, School of Science and Science Education, Federal University of Technology, Minna.

……. ……

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DEDICATION

I dedicate my entire life, belongings to almighty ALLAH the creator of all from birth till death including this project work.

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First of all, I give all glory, honour and adoration to almighty God who has been very faithful and good to me all the day of my life. My profound gratitude goes to my very patient and accommodating project supervisor in person of Mr. J.F Maigida, whose enormous contributions cannot be overlooked and my Head of Department in person of Dr.Ohize for his encouragement and fatherly advice. I owe a debt of gratitude to my parent Alhaji M.O SADIQ ,MRS T.O SADIQ who were always there for me. I also want to use this opportunity to thank my family may almighty ALLAH continue to gratitude to my uncles, aunties, cousins and my friends who really assisted in making this a success. Lastly, my thanks also goes to all the distinguish lecturers of the department of Industrial Technology and Education who have supported this research to make it a successful one.

ABSTRACT

This study was designed to determine the effect of 3D building model on student academic performance building technology in technical colleges in Niger state. Two technical colleges were selected for the study using simple random sampling technique. One of the schools was used as the experimental group and the other one as the control group. 20 students were randomly selected for each consisting of male and female of equal proportion. The experimental group ware taught using 3D building model and the control group were taught using the conventional building model. The research instrument used for the study was building technology Achievement Test covering the topic selected for the study. The data were collected and analyzed using t-test statistics respectively. Two hypotheses were postulated and tested at 0.05 level of significance. After the analysis and final result was gotten, it showed that students who were taught using 3D building model performed better than those that were taught using the conventional lecture method. In the light of that, it was recommended that 3D building should be used for the teaching and learning of building technology in technical colleges.

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CHAPTER ONE

INTRODUCTION

Background of the study

Buildings are constructed to serve the needs of their occupants. Occupants need Facilities with comfortable, safe and healthy environments, utilities and technical equipments to perform their work. Building systems may be defined as a group of electro-mechanical components connected by suitable pathways for the transmission of energy, materials or information and directed to a specific Purpose. An integrated approach to building systems gives consideration to the Overall objectives rather than the individual elements, components and Subsystems. Traditionally, coordination of building systems is primarily between mechanical and electrical engineers that is passed down the line to contractors to coordinate on site. In the past two decades the integration of diverse technologies such as mechanical, electrical, bioclimatology, geophysics, optics, electronics and computer engineering plays an important role in the design of building systems and the environment they control. Building systems applications may include heating, ventilation, air conditioning, and cooling (HVAC); lighting; power; security; fire and life safety; building automation; audiovisual communications and computer networking of various kinds. Because of the large number of interrelated factors in these systems, there can be many solutions to the same building problem, all of which will satisfy the minimum requirements (Ahuja,1997).

The computerization and integration of building systems technology and the

Information age we live in have changed the way humans perceive their habitat. Computers are mathematical instruments of enormous value in the science of building systems design. Computer-aided design (CAD) systems are extremely

valuable tools in drafting and modelling. This chapter introduces 3D CAD modelling as a tool to support the coordination of building systems in designing,

construction and maintenance. Nowadays 3d modeling is being used even more widely from medicine to engineering applications. The involvement of Geomatics engineering with use of spatial data and the improving use of geographic information systems, both in our country and around the world, and the need to be relieved from the restrictions analog maps revived the subject of intense use of digital maps and spatial modeling. 3D modeling and visualization has made a rapid development parallel to the technology, especially altogether with animations, the use of these models are more frequent than it was before. Early computer graphics were Vector graphics, composed of thin lines whereas modern day graphics are Raster based using pixels. The first triangulated irregular network program for GIS was written by Randolph Franklin at Simon Fraser University in 1973. A major breakthrough in simulating realism began in 1975 when the French mathematician, Dr. Benoit Mandelbrot published a paper called "A Theory of Fractal Sets." After some 20 years of research he published his findings and named them Fractal Geometry. At the 1980 SIGGRAPH conference a film entitled "Vol Libre" was shown. It was a computer generated high-speed flight through rugged fractal mountains. A programmer by the name of Loren Carpenter from The Boeing Company in Seattle, Washington had studied the research of Mandelbrot and then modified it to simulate realistic fractal mountains.

Two-dimensional forms, recognize, depth and distance proximity. Identify and understand relationships of location, position, scale and size. Spatial orientation refers to the ability to recognize the identity of a object when it is seen from different angles.(Tremblay,2004).

Spatial ability is fundamental to human functioning in the physical world, spatial reasoning enables an individual to use concepts of shapes features and relationship in both concrete and

abstract ways, to make and use things in the world to navigate, visualize and to communicate (Newcomer,Raudebaugh,Mckelland Kelly.1999).In a similar way this ability is used to envision new things and establish relationship of concepts in the mind (jones and bills 1998).

Basham(2007) noted that spatial ability is basic to higher level activities such as mathematical thinking and used for processing information presented in such representation s maps, graph, diagrams and other spatial layout. According to Olkun (2003)spatial thinking is used to represent and manipulate information in learning and problem solving in engineering designs,physics and mathematics.

Solid modeling in AutoCAD

AutoCAD is on of the computer aided design (CAD) software package currently available for graphic design. It is an interactive drafting software package for construction of object on a graphics display screen, according to Bui(2004)AutoCAD is a vector graphic software developed in early 1980s by Autodesk incorporation for Two-dimensional and Three-dimensional design and drafting. It uses primitive entities such as lines, poylines, circle, arcs and as foundation for more complex object(Wikipedia,2007)AutoCAD provides users with solid modeling option, vpoint, solview and soldraw commands.

Statement of the problem

Technical college graduates are suppose to have three options according to the National policy on Education(FGN 2004) is either to secure employment in the industries, pursue further education in higher technical institution or set us a business and become self employed. One of the causes of high failure rate of student in recent years according to NABTEB(2002) chief examiner reports is partly due to teaching methods

In view of the above observation, this researcher is designed to examine the effect of 3d building model on student academic performance in building technology in some selected government technical college in Niger state.

Purpose of the study

The main purpose of this research is to find out the following

1. To find out the effect of 3D building model on student academic performance in building technology in some selected government technical college in Niger state.

2. To find out the differences among male and females students taught with 3D building model

Significance of the study

Since the study is aimed at funding the effect of 3D building model on students academic performance in building technology, the conclusion arrived at in this study is going to be of importance to teachers, students and curriculum planners

1. It will increase the use of information technology in building technology.

2. To helps students view building models from different angles.

3. To help students improve their design quality.

Scope of the study

This study is limited to government technical college NTC1 students. Two schools were drawn from government technical colleges in Niger state. The study hope for the successful effect of 3D building model on student academic performance in building technology.

Research Question

1. What is the effect of using 3D building model in teaching building technology

2. Is there any difference among male and female students taught using 3D building model.

Research Hypotheses

The research hypotheses therefore are:

1. There is no difference in the mean achievement score of the students taught using 3D building model and those taught using the conventional method of building model.

2. There is no difference in the academic performance of male and female students taught using 3D building model.

CHAPTER TWO

LITERATURE REVIEW

This chapter attempt to present a review of related literature in textbooks, magazine, journals.

The literature for this study was review under the following sub heading

1. What are 3D CAD models
2. The role of 3D models in design and construction
3. The advantages of using 3D CAD modeling in design and construction
4. Using 3D CAD modeling as a means of knowledge sharing

What are 3D CAD Models?

3D CAD models are three-dimensional computational representations of objects drawn in the x, y and z axes and illustrated in isometric, perspective or axonometric views. These views are achieved simply by rotating the viewpoint of the object. A 3D CAD model of an object in general provides the following advantages: (a) an object can be drawn once and then can be viewed and plotted from any angle; (b) A 3D CAD object holds mathematical information that can be used in engineering analysis, such as finite-element analysis and computer numerical control technology; and (c) A 3D CAD object can be shaded, rendered and assigned various materials for visualisation. 3D CAD models can be generated by the use of various types of CAD software systems such as AutoCAD, Microstation, ArchiCAD and many more.

The role of 3D CAD models in design and construction

An understanding of the ways in which 3D CAD modelling techniques can be used to support and reflect design thinking, can then lead to the development of a greater integration in the building design and construction industry. Since the inception of CAD, computers appear to have played a vital role in the practice of architecture, engineering and their allied profession. This however, is merely an illusion. This simply did not happen because most designers in practice were not formally trained to use the computer as a productivity tool, they are unfamiliar with its capabilities. In fact, this practice still utilises designers who develop conceptual sketches for a project, then these sketches are passed on to draftsperson who create 2D design development and construction document drawings of little integration, if any, with other building or discipline consultants.

The primary purpose of a 3D CAD model needs to be established at early stages in a project. 3D CAD modelling can be used in structural, lighting, acoustic, thermal, acoustic, bio-climatic and spatial analysis. This Chapter is not intended to cover all of these important issues but rather to focus on the use of 3D CAD

modelling to support the coordination of building systems. A common misconception of CAD systems is still as drafting tools in the post-design stages of work rather than playing a much more richer role in designing and construction. 3D CAD models could help to resolve ambiguities, provide linkage to design data and present computerised visualization.

Using CAD modeling in building systems

In earlier times wherein computers were not yet developed, there has been a representation of using conventional media in designing. Ancient architects used text to abstractly describe the design process (Hewitt, 1985). 2D drawings were later introduced and only expressed abstract visual thinking. Then with the massive use of physical models in the Renaissance, the form of space and architecture was given better precision. The attempts have been continued to identify the nature of different design tools. On recent years, digital technology has been developed and matured at an unprecedented rate. This growth has led to a converging phenomenon that erodes the traditional boundaries of computing. Compared with conventional design media it is worth employing computer technology meaningfully to bring significant changes in the process of building systems design and maintenance.

The conventional approach involves the use of drawings and models as means of representing the basic convention. The type of models used in the design process can either be a physical or digital model. Both types were used as a means of solving complex problems that 2D drawings were unable to handle (Lin, 2001).

3D building models are useful across the entire spectrum of architecture, engineering and construction (AEC) practices. Architects and their clients use 3D building models to observe and evaluate building designs before construction, while there is still chance to make substantial changes at a reasonable cost. Engineers use 3D building models for energy, lighting, acoustics and fire simulations. The results of these simulations give valuable insight into building useability and safety. Professionals in the construction industry utilize 3D models to estimate costs and to plan cost-effective construction sequences. This process often leads to early discovery of design conflicts that would otherwise result in expensive construction mistakes. Even for an existing building, it is often desirable to have a 3D models

to analyse the energy properties of the building or to explore how a potential fire might spread to study potential changes to the building, or to study possible uses of existing building spaces (Lewis and Sequin,1998).

Drafting is still associated with the common perception of the application of CAD to architectural design. CAD technology has progressed to a level in which it is possible to communicate design expressions representing early stage design ideas right through to detail drawings. This is quite different from CAD as an instrument for efficient production, or as a vehicle for the graphic presentation of the already designed building. Being able to use 3D CAD systems fluently is synonymous with being a good designer, rather than a draftsman (Szalapaj,2001).

Advantages of using 3D CAD modeling in building design and construction

The advantages of 3D CAD modeling cover the whole plant-life from layout and design to construction and maintenance. The development of 3D CAD software systems has enabled planning procedures to be changed from 2D for each engineering discipline (piping, wiring, HVAC, etc.) to an integrated 3D planning procedure. 3D CAD modeling encourages users to plan work thoroughly to create their documents. After a 3D model of the building structure has been built from architectural and structural drawings, the main internal equipment is added.

The draft arrangements of the different engineering disciplines determine the allocation of the available space and planning can start. Since a designer from one discipline can see the results of the other disciplines' work, a visual collision check is performed during the planning procedures. The visual collision check is currently carried out via a walkthrough inside and around the 3D CAD model.

When planning is finished for the rooms involved, an automatic collision check is performed, which normally a handful of collisions to be eliminated. Further modifications, desired by the project manager or client for example, can be accounted for (Lockau, 1996). 3D geometric CAD models usually are in the form of wire frame and solid modeling. Wire frame modeling, still widely used by architects, is known as the ancestor of contemporary CAD presentation. The nature of wire frame models reveals the underlying structure of the building, thus helping architects check the project's buildability. Due to this ability, wire frame modeling is used for establishing the building's skeleton in the developmental design stages of most CAD programs. Solid modeling is usually utilized for the finished model.

Despite wire frame modeling’s advantages; some architects prefer using solid modeling in the primary stages as well as in the final stage. The difference between wire frames and solid modeling is parallel to the difference between using paper/pencil and a 3D object like wood or foam to construct the initial design. Even if solid modeling is used from beginning to end, the first draft does not look remotely like the finished design. In the early stages, the architect is not interested in making the building look realistic, only in outlining the rationale of the design. The importance of the computer is as an interface between the physical design and the abstract ideas behind it. It the later stage of design, realistic elements, like colour, lighting, and shadows, are added to help communicate the building design to the client.

3D CAD integrated systems such as Architectural Desktop and Microstation Building Plant and Engineering enable the designer to seamlessly integrate mechanical and electrical design within the building structure. This allows exchanging accurate design information with other industry professionals. With the addition of Internet capabilities, this provides the designer with the ability to leverage this power in order to enhance coordination among the entire design and construction team. This will help in reducing design cycle time while offering useful tools for design and construction documentation. Furthermore, scheduling information

and space planning data can be extracted and exported to external databases for further analysis to assist building owners in post-construction facilities planning and management. It enables facilities managers to track room square footage, maintain assets like furniture and equipment, track asset quantity and cost, and export this data to external databases for reports. From a coordinated 3D CAD model, individual services layouts can be generated for example ductwork, mechanical pipe work, public health, fire protection and electrical services using relevant layers with text and dimensioning.

These can be output for accurate tender pricing, and the on coming Contractor can use the full coordinated drawings for installation purposes. The resultant model can be utilised for external and internal visualisation and animation, thermal calculation, lighting design, sun studies and crowd evacuation. These are coordinated within the prototype and continuously tested for clashes and discrepancies. Fully coordinated construction drawings are produced directly from this model. This will shorten the overall design coordination period, identifies construction problems within the computer, thus saving time and money, improves productivity and reduces defects on site.

Using 3D CAD Modeling as a means of useful knowledge sharing

Building design is a process that often been considered as an activity carried out by architects and engineers. They are co-designers in proposing the end product of a building form, materials, supporting structure and environmental control services. However co-designers share the same task, that is designing a specific building, they seem to think rationally about concepts with regard to their own particular interest in the evolving building solution. Their co-designing work is in the form of knowledge contribution from each of them based on their particular experience. Their method of working together will therefore be in the form of

knowledge sharing in order to evolve a commonly agreed building solution. Knowledge sharing by each of the co-designers can only occur particularly if they can exchange design information which will present the output and input to their individual knowledge contribution (Cornick, 1996). Example of the knowledge shared among the co-designers include: shapes, proportions, arrangements, and materials of building element brought together in an overall building form; structural and services elements and enclosures with regard to their structural stability; and size, shape and arrangement of building services. The development of a 3D CAD model has an essential role to support the knowledge sharing among co-designers. One set of designers conceive the overall form and how all its parts would fit and work together, other designers conceive how all the system parts can be engineered as an overall assembly. The degree of realism that can be created in the 3D CAD model and the ease by which 3D views can be generated are essential in knowledge sharing. This is a much richer notion than demonstrating the material finish and form of building objects

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter contains the methodology and procedure used in carrying out this work. Also effort were taken to work out the appropriate research methodology to ensure reliability of the findings of this research

Research design

The quasi experimental research design was used for the study involving the pre-test, post-test, experimental and control group.

Area of study

The study was conducted in some selected government technical colleges in Niger state Nigeria. Which entails the Government technical college minna and Government technical college New bussa Niger state

Population of the study

The total population of students from both school is 60, government technical college minna has 32 students offering building technology and government technical college new bussa has 28 students offering building technology

Sample and sampling techniques

The sample size for the experiment is 20 students which was drawn from government technical college minna and anothere 20 students drawn from government technical college new bussa.They were both used respectively as control group and experimental group to test the hypotheses(HO1).Another 20 atudents compromising of ten(10) and ten(10)female students were drawn to test the hypotheses on gender disparity.

TABLE 3.1 Distribution of students selected for experimental and contol group of the study with their respective schools

School	Sex of sample	Sample size	Total
Government technical college minna	Mixed sex	20	20
Government technical college new bussa	Mixed sex	20	20

Research Instrument

The instrument used for collecting data was fifteen(15)objective question,the scope of th test was limited to the concept treated in building technology. The item consist of fifteen objective questions each with four(4) options, where the correct response attract one mark after which the overall scores were converted into percentage and further subjectd to statistical analysis.

Validation of the instument

After testing for validity,the instrument was administered to 40 building technology student and then results were collated, after a period of wo weeks the test items were readministered to the same students,the first and second result were corelated using pearson product moment correlation (PPMC).

Experimental procedure

The experiment commenced with the administration of pretest to all the treatment groups,building technology teachers and their assistants administred the pretest to the

treatment group in their respective schools.After the pretest two weeks intensive training of AutoCAD techniques was given to all th treatment groups by building technology teachers in their respective schools

The treatment group assigned to AutoCAD 3D techniques was taught with AutoCAD 3D lesson plan.Building tchnology teachers in each of the classroom used for the treatment was organized in such a way that there was one computer to each student.

Method of data analysis

The scripts of the post-test were scored, collated, coded and analyzed using statistical analysis to find solutions to the questioned raised using mean, standard deviation and t-test. They were computed to test the mean scores of the two groups of students used in the study. The significant level for testing hypotheses is at 0.05. this level of significance formed the basis for retaining or rejecting each stated hypotheses.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA

This chapter consists of data analysis, presentation of results and general discussion of the results. The pre-test and post-test data collected from the study were statistically analyzed using t-test. The procedure for testing the hypotheses of the study using analyzed data is presented as follows:

Presentation of results

The summary of the data analysis and result is presented below:

table 4.1 pretest mean score of experimental and control group

Variables	N	d.f	Mean	Sd	t-value calculated	t-value critical	p≤
Experimental group	20	19	8.90	2.90	1.140	1.684	0.05
Control group	20	19	7.85	2.77	1.140	1.684	0.05

Source: Field survey,(2012)

The result in table 4.1 above shows no significant difference between the pretest mean score of the experimental group (8.90) and the control group (7.85).This shows that both

groups were at same entry level of academic ability before the use of 3D CAD building model for instruction.

Hypotheses 1(H01)

There is no significant difference in the mean achievement score of students taught using 3D CAD building model and the conventional building model

table 4.2 post-test mean score of the experimental and control group.

Variables	N	d.f	Mean	Sd	t-value calculated	t-value critical	p≤
Experimental group	20	19	10.3	3.33	3.14	1.684	0.05
Control group	20	19	7.35	2.38	3.14	1.684	0.05

Source: Field survey,(2012)

Table 4.2 shows that the post-test mean score of experimental group is (10.3) and the control group is (7.35).The calculated t-value(3.14) is greater than the critical t-value(1.684).Thus, this implies that, there is a significant difference in mean achievement score of students taught using the 3D CAD building model and students taught traditional building model. Therefore, the null hypothesis (HO1) is rejected.

Hypotheses 2(HO2)

There is no significant difference in the mean achievement score of male and female students taught with the 3D CAD building model.

table 4.2.3 post-test mean score of male and female experimental and control group.

Variables	N	d.f	Mean	Sd	t-value calculated	t-value critical	p≤
Male group	10	9	9.1	3.21	1.127	1.725	0.05
Female group	10	9	7.5	2.81	1.127	1.725	0.05

Source: Field survey,(2012)

Table 4.3 result shows that the calculated t-value(1.127) is less than the critical t-value(1.725).This indicates that there is no significant difference in the post-test mean score of male(3.21) and female (2.81) students taught using 3D CAD building model. Thus, the null hypotheses 2(HO2) is accepted.

Discussion of results

The results of table 4.1 indicated that the two groups were at same entry level with regards to their academic ability before the teaching was presented to them. Hence, there is no significant difference in their test mean score.

The result in table 4.2 indicated that there was significant difference in the achievement of students taught using 3D building model and those taught with the conventional building model. This implies that the experimental group performed better than the control. This means that use of 3D building model had a positive influence on student performance. Thus, the word of Adeoti(1998), can be quoted who defined instructional material as things which are intended to help the teacher to teach more effectively and also enable the pupil to learn more effectively

The result in table 4.3 indicated that there was no significant difference in the performance of male and female students taught using 3D building model. The result shows equality on their performance towards the concept. That is, both the male and female students have similar performance. Thus, this result supports, Alfa(2007).who stated that there is no significant difference in the performance o male and female students in WAEC and NECO result score. Also Nwogy(2006)and Gambari(2003)found the performance of male and female student equal in their study

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

summary of the study

The main purpose of this study was to determine the effect of 3D building model on student academic performance in building technology among Government technical college students in Niger state. The exposure of students to 3D building model significant difference in the performance of students taught using 3Dbuilding model

There was no significant difference in the performance of male and female students taught using 3D building model from above we could see that this as contributed its own quote to knowledge.

1. Making the teachers aware that the students remember greater part of what they se and hear alone therefore, the supremacy of 3D building model over the conventional building model is made clear

2. Encourage teachers to use 3D building model in teaching building technology lessons for proper understanding and retention of some building technology concepts.

3. Understanding that the use of 3D building model makes teaching faster, serves time and energy of both the teacher and students.

conclusion

In this study, the effect of the use of 3D building model in teaching building technology was investigated. On the findings of the study, the following conclusions were drawn:

1. Teaching with multimedia (3D CAD)saves time makes effective teaching and improve performance of students in building technology

2. The student's enthusiasm and participation during the teaching, using the 3D building showed that they were happy and seemed to understand more than the conventional building model.

3. There was increased in the performance of students in building technology when 3D building model is used to teach compared to those taught conventional building model.

Recommendations

The following recommendations were made

1. Building technology teachers should be encouraged as much as possible to use multimedia instruction. This will enhance the better understanding of concepts in sciences.

2. The government and schools should aimed at providing computers and other peripherals needed for effective and efficient utilization of 3D CAD building model in teaching and learning

3. Further curriculum development should take full account of the potential of a new technology.

suggestions for further study

1. This research can be carried over in the other part of the country to ascertain the effect of 3D building model on student academic performance, and in other concepts in building technology.

2. This can be carried out involving more schools within and outside the state .

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