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Appraisal of the Effect of AutoCAD Software Package on Mechanical Trade Students' Spatial Ability and Academic Achievement in Technical Drawing in Technical Colleges in Delta State

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Abstract

The study appraises the effect of AutoCAD software package on mechanical trade students' spatial ability and academic achievement in technical drawing in technical colleges in Delta State The study adopted quasi-experimental design and it was guided by two research questions as well as one null hypotheses were tested in the study. Population of the study was 160 National Technical Certificate (NTC 11) engineering trade students in state owned technical colleges. Purposive sampling technique was used to draw four schools out of the six technical colleges from mechanical trade. Instruments for data collection were Technical Drawing Achievement Test (TWAT) which was face and content validated by three experts. The instrument was tested for reliability using test–retest method and was calculated using Pearson Product Moment Correlation and the overall correlation coefficient value of 0.87 was obtained. The arithmetic mean was used to answer the research questions and standard deviation to determine the heterogeneity of students'. Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0. 5 level of significance. The study revealed that students in the experimental group obtained higher mean scores than those in the control group. The paper concludes that the use of AutoCAD could improve the teaching of technical drawing in technical colleges as well increase students' intellectual capacity. In view of the positive effect of AutoCAD software package, it was therefore recommended amongst others, that the AutoCAD software package should be vigorously adopted for teaching TD to promote students' spatial ability and overall academic achievement.

Keywords: AutoCAD, Technical Drawing, Mechanical Trade, Lecture/Demonstration Teaching Method, Spatial Ability, Academic Achievement and Technical Colleges.

Introduction

The advancement of automation has brought changes in work processes as well as the method of imparting and acquiring relevant knowledge. As a result of increasing industrialization in modern times, knowledge and skills in engineering trade courses become increasingly essential in everyday life Wilfred, (2016). The aspiration to inculcate innovative knowledge and creative skills necessitated a change to improve the preparation of engineering trade students for functioning in a continually changing and highly demanding conducive learning environment. Therefore, education systems all over the world are under increasing pressure to appropriately utilize the digital tools to teach students in the 21st century (UNESCO, 2009). Similarly, the emergency of a new understanding of knowledge

construction and the reciprocal relationship between the teacher and learner are absolutely essential in engineering education especially in mechanical trade.

Mechanical trade is a general name used in describing trades that have direct bearing with metal welding/forming and servicing/repairs of machines or machine-related equipment and appliances. Mechanical trade(s) include: Motor Vehicle Mechanics Works, Fabrication and Welding Craft Practice, Air-conditioning and Refrigeration Mechanics Works, Mechanical Engineering Craft Practice and Foundry Craft Practice among others (Federal Republic of Nigeria-FRN, (2014). The effective teaching and learning of mechanical engineering trade would prepare students for the world of work. It will enhance students' practical skills and as well prepare them for higher education of learning that would enable them to become knowledgeable in the field of engineering and technology. Likewise, at technical colleges under study, all the students in engineering trades are taught technical drawing as a trade related course.

Technical drawings (TD) encompass the architectural, civil, structural and mechanical professions. They are means of conveying diagrammatic detailed aspects of the design components of a structure. It could be the outcome of creative thought by an engineer or technologist. TD teachers especially in technical colleges should develop and employ various instructional methods which could encourage students to actively participate in the learning process (Eze and Emili, 2014). It is therefore hoped that when this is achieved by TD teachers in technical colleges, it would encourage students' interest to work at a higher intellectual capacity. The ultimate aims of studying TD are; to develop the ability to produce simple manufacturing drawing and sketches based on current practice, to develop the skills to read manufacturing and construction drawings used in present industries, to develop a working knowledge of the layout of plans and equipment and to develop skills in abstracting information from calculation sheets and schematic diagrams to produce working drawings for manufacturers, installers and fabricators. TD could also help to facilitate the development of knowledge and skills related to reading, interpretation of drawings, recognizing drawing in one form and where necessary change it into more applicable form, making use of conventional symbols and applying the principles of drawing to the construction of bridges, structural buildings, design and construction of motor vehicles and aircraft.

The use of TD could be advantageous as it might lead to low cost of equipment, brings about clarity to drawing by enabling holistic view of sold shapes, sizes and angles on one sheet. It could enhance and accelerates creativity in style and expression in drawings, produces a depth and weight that could be easily demonstrate its technicality. Furthermore, it could be easily modifying a manual drawing and does not require as much technical ability. TD allows efficient communication among engineers and could be kept as a record of the planning process. Since a picture is worth a thousand words, a TD is a much more effective tool for engineers than a written plan. Conversely, TD may take a longer time to post or fax to the client, there is the need for better illumination to work on the drawing. The equipment could be affected by human error due to shaky hand or an unsettled mind and may take a long time to construct or reproduce a drawing during manually drawing. Specifically, TD is one of the core subject offered at technical colleges.

Technical college is an institution designed to train individuals at semi-skilled level especially, as artisans, craftsmen and technicians in their area of interest and specialization to make them self-reliant and self-employment (Deebom, Dokubo and Obed, 2018). Technical colleges in Nigeria are established to produce craftsmen at the craft level and master craftsmen at the advanced craft level (Okuntade, 2014). On completion of the three years programme in technical college, the students are awarded National Technical Certificate (NTC), while Advanced National Technical Certificate (ANTC) could be obtain after the end of NTC with added years of working experience.in industry before enrollment of ANTC examination. The ultimate objectives of establishing technical colleges are; to provide trained manpower in the applied sciences, technology and business craft at an advanced craft and technician levels, to enhance technical knowledge and vocational skills necessary for agricultural, commercial and economic development; and to give training and impart the necessary skill to individual who shall be self-reliant economically (FRN, 2016). In technical colleges, when students from different trade areas are exposed to practical learning activities that exist in the real world of work, there could be an improvement in cognitive and psychomotor skills as well as an accelerated delving into reality of spatial reasoning and ability.

Spatial ability is the intellectual capacity used to function and operate in 2-dimensional or 3- dimensional spaces. It is a cognitive function that makes it possible for human to deal effectively with spatial relations, visual-spatial tasks and orientation of objects in space. Spatial ability is the ability to think in picture, to create mental images and to transform visual or spatial ideas into imaginative and expressive creation (Jimoh, 2010). In these same vein, spatial reasoning enables an individual to use concept of shapes, features and relationships in both concrete and abstract ways, to make and use things in the world, to navigate, visualize and to communicate. Thus, when spatial aptitude is correctly applied in teaching and learning in TD digital classroom could promote students' academic achievement.

Academic achievement refers to knowledge and skills attained by a student in a school subject designated by a score obtained in an achievement test. An achievement test is an instrument administered to an individual to elicit certain desired and expected responses, as demanded in the instrument, performance on which the individual is assigned a score representing his achievement (Ahassan, 2012). Academic achievement is appropriate in determining the efficiency of instruction and also useful in testing of information retention of knowledge.in engineering education.

Over the years, graduates of engineering trades have serious difficulty in learning with conventional / traditional method such as lecture / demonstration teaching methods L/DTM in TD in technical colleges (Eze and Onwusa, 2020). Accordingly, NERDC, students perhaps would not work at their own speed. The fact that L/DTM is teacher-centred, it could not provide students with experiential learning environment that could facilitate better understanding of spatial properties and relationship of objects and space. Supporting the above assertion, Oluwale, Jegede and Olamade, (2013) noted that with the manual tools, it could be very difficult to solve complex drawing problem easily. Accordingly, Kumazhege, (2015) revealed that manual tools may lack accuracy and consistency both in appearance and in performance. The abstract nature of presentation of TD could not encourage the class to progress without a great deal of the teacher's intervention. Thus, problem solving and thinking skills could only be developed when a learner may perhaps construct his/her own knowledge which is part of constructivist approach to learning especially in practical – oriented subject (NERDC, 2013).

However, Prensky, (2001) an authority on teaching and learning particularly with the aid of Information and Communication Technology has referred to 21st century children born after 1980 as Digital Natives. Digital Natives are the children who have grown up into a world surrounded by and using computers, videogames, digital music players, video cams, Android phones and all the other modern technological toys and tools. Also, Prensky, (2001) is of the view that they are the product of the new culture that has emerged as a result of the aggressive penetration of digital technology in the lives of young people born since the last two decades of the 20th century. Prensky, justified this label with the explanation that they are all 'native speakers of the digital language of computers and the Internet. Consequently, they have the skills for digital fluency (Onwusa, 2019). Thus the sudden shift to the online digital world has rendered that experience irrelevant to modern students. Hence, many application software packages have been developed for Computer-Aided Design, including the Automated Computer Aided design popularly known as AutoCAD.

The AutoCAD is regarded as an interactive drafting software package developed for construction of objects on a graphic display screen. The concept of AutoCAD evolved way back in the 1980's, when engineers and architects were seeking to harness the power of newly introduced personal computers to reduce the drafting time. People began experimenting with internal graphic controllers which allowed them to draw engineering / architectural drawings at the front end which were efficiently replicated at the back end of the computer. Autodesk and AutoCAD, (2020) defined AutoCAD as a means of using computer systems to assist in the creation, modification, analysis, or optimization of a design. AutoCAD was officially launched in December 1982 by Autodesk, a leader in 3D design, engineering and entertainment software. Autodesk, the company behind AutoCAD, has developed custom versions that could be used by design engineers, civil engineers, electrical and electronics engineers and mechanical engineers. Most essentially, CAD software could be used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and create a database for manufacturing.

AutoCAD which is one of the most powerful CAD software used in the industry offers two different techniques (2-D and 3-D) of graphics task (Taylor and Parsons, 2011). These two technique used in AutoCAD technology and software are the two-dimensional and three-dimensional Cartesian coordinate systems. Whereas, the AutoCAD two-dimensional Cartesian coordinate system is a two-dimensional Computer-Aided Design, used for graphics construction in AutoCAD environment through the specification of coordinate with the X and Y Cartesian coordinate system only. The AutoCAD three-dimensional use three-dimensional Cartesian coordinates system in AutoCAD environment (Jimoh, 2010). Two-dimensional drawing is related to rectangle, square, triangle, polygon, etc., while three-dimensional drawing is related to cylinder, cube, sphere, pyramid, prism and more. In contemporary times the three-dimensional technology could be a crucial tool Digitemie and Emeli, (2016). Consequently, making use of three-dimensional is no longer limited to designers, automobile engineers, architects and aerospace suppliers (Taylor and Parsons, 2011).

The advantages of the software package in the teaching and learning of TD could make drawing accurate, enhance speed in the drawing process, enable the students not only to draw legibly, but to improve clarity in drawing, could make students consistent and thus promote uniformity in drawings. It could as well boost students' interest and engagement in learning activities. Additionally, it could make the drawing more creative and purposeful, and aid students to develop problem solving abilities. In the same way, it could improve design documentation with less transcription errors, create manufacturing database as well as provide easier modifications and alterations in drawings. Above and beyond, it might increase productivity of the designer, simulation and virtualization Usoro, (2013): Usikpedo, (2022).

The attitude of students towards learning TD with the manual drawing instruments such as drawing board, T-square, protractor, set squares, drawing sheet, drawing pencils, compass, pair of divider and drawing pins/clips has become a major issue of concern as many students learning this subject, approach it with phobia. This has led to the teaching more but learning less syndrome because many students find it difficult to manipulate these instruments. Thus, making students learning it with tears, devoid of interest and low level of engagement which could lead to severe failure and high dropout level in the subject (Eze and Emili, 2014). In addition, the authors stated that students learning TD are performing below expectation in technical colleges in an important examination such as National Business and Technical Examination Board- (NABTEB, 2012).

However, this falling academic achievement in TD calls for an immediate and urgent solution. Thus, it becomes necessary to employ alternative technique of teaching, for instance the use of AutoCAD software package to see if students' overall academic achievement could improve in subsequent examination especially in TD in technical colleges. It is not clear yet to the researchers whether the use of AutoCAD software would improve the mean spatial ability and academic achievement of students' taught TD using AutoCAD software package compared to those taught using DTM. Hence, the need to appraise the effect of AutoCAD software package on mechanical trade students' spatial ability and academic achievement in TD in technical colleges in Delta State, Nigeria.

Purpose of the Study

The purpose of this study therefore was to appraise the effect of AutoCAD software package on mechanical trade students' spatial ability and academic achievement in TD in technical colleges in Delta State. Specifically, the study seeks to determine the:

1. Mean spatial ability scores of students taught TD with AutoCAD and those taught with DTM.
2. Mean academic achievement scores of students taught TD with AutoCAD and those taught with DTM.

Research Questions

The following two research questions guided the study:

1. What are the mean spatial ability scores of students taught TD using AutoCAD software package with those taught using DTM?
2. What are the mean academic achievement scores of students taught TD using AutoCAD software package with those taught using DTM?

Hypotheses

The null hypotheses were tested at 0.05 level of significance was used for the study.

1. There is no significant difference between the mean academic achievement scores of technical colleges students taught TD with AutoCAD software package with those taught using DTM.

Methods and Materials

Quasi-experimental design was adopted for the study. Specifically, the pretest, posttest non-randomized control group design was adopted for the study. The design was adopted because it was not possible for the researchers to randomly sample the subject and assign them to groups without disrupting the academic programme and the timetable of the technical colleges was used for the study. The study was conducted in technical colleges in Delta State which is located in the south-south zone of Nigeria. The population of the study taking TD in the four schools was 160 Mechanical Trades National Technical Certificate (NTC 11) students. The two schools used for experimental groups are Utagba–Ogbe Technical College, Kwale and Agbor Technical College, Agbor with total population of 89 students while the two schools used for control groups are Sapele Technical College, Sapele and Ogor Technical College, Ogor with total population of 71 students respectively. Purposive sampling technique for selecting the four schools was based on availability of professionally qualified staff in AutoCAD, technical colleges offering mechanical related trades, manageable population for the study, technical colleges with computer facilities/ laboratory for teaching and learning and schools with regular electricity supply. Also willingness of classroom teachers to participate as research assistants as well as interest and engagement of students in TD in these four schools. TD is a graphic representation of some real entity, such as machines parts/components and tools/equipment in mechanical trade. The mechanical trade(s) are as follow: Motor Vehicle Mechanics Works (MVMW), Fabrication and Welding Craft Practice (FWCP) and Mechanical Engineering Craft Practice (MECP). The trade categories of the students for the experiment was crucial because it relates to the specific function to be performed by the students in their chosen trade of study.

One intact class was used in each of the four schools giving a total of four intact classes. Intact classes mean that entire classes are assigned to specified treatments. For the purpose of this study, two intact were classes assigned to experimental group and the other two intact classes to control group respectively. The instruments for data collection was Technical Drawing Achievement Test (TDAT) adapted by the researchers from the NABTEB past examination questions between 2020, 2021 and 2022. TDAT contained 40 multiple choice test items with four options (A-D) and 10 theory questions to test spatial ability. TDAT lesson plan were validated by a panel of three experts from the departments of Mechanical Engineering and Computer Science from the Delta State University Science Technology. Ozoro. They considered the simplicity of the software package as well as its suitability for the instrument. They verified the extent to which the items of each unit was effective for teaching, and considered for testing the topic they were meant to test, checked the possible errors and suggested answers. Based on the comments, corrections and advise of the experts, the original package was edited by the researchers for the final draft. The package was used for the study. The copies of the research instrument were administered to the technical college students drawn from the Government Science and Technical College Onitsha, Anambra State who were not part of the population studied. The instruments were tested for reliability using test–retest method and was calculated using Pearson Product Moment Correlation and the overall correlation coefficient value of 0.87 was obtained.

Experimental Procedure

The researchers sought and obtained permission from the authorities concerned for the involvement and participation of their students and teachers in the study. In the first week, the researchers visited the schools for orientation for the participating research assistants. The technical drawing teachers were trained on how to conduct the experiment treatment and were given prepared lesson plans and notes. Teachers of the control group were instructed to use DTM, while the teachers of the experimental groups used AutoCAD software package for teaching. Likewise, students of experimental groups were given training on how to maneuver computer and AutoCAD software package. To reduce experimental bias, the regular TD classroom teachers in the participating schools taught their own students. Hence, the researchers were not directly involved in administering the research instruments and the treatments.

The pretest was administered with the help of research assistants (the class teachers) to determine the initial abilities of the students prior to the experiment. In the second week, the teaching commenced and ended on the fifth week. The primary focus of the teaching process was concentrated on drawing in AutoCAD environment. Each lesson lasted for 80 minutes and the treatment lasted for five weeks. The teaching was conducted during the normal school period using the school time table. The exercise provided a posttest data for each of the dependent variables. The experimental group wrote the examination using the AutoCAD software and students saved their drawings in CDROM and was printed before submission to the classroom teachers. The control group wrote the examination with manual drawing instruments and the research assistants supervised the examination, marked the scripts, recorded the marks and made the scores available to the researchers.

Data collected for the study were analyzed using mean scores and standard deviation to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. In the test of null hypotheses using ANCOVA, when the p-value was less or equal to the level of significance (0.05), the null hypothesis was rejected. Also, when the p-value was greater than the level of significance (0.05), the null hypothesis was not rejected. The pre-test and post-test scores were used for data analyses using Statistical Package for the Social Sciences (SPSS) version 25.

Data Presentation, Analysis and Study Results

Research Question 1

What are the mean spatial ability scores of students taught technical drawing using AutoCAD software package with those taught using DTM?

Table 1: Mean of Pretest and Posttest Scores of Treatment Groups taught Technical Drawing using AutoCAD software technique with those taught using DTM

		Spatial Ability				
Groups	**No**	**Pre-test**		**Post-test**		**Mean Gain**
		Mean	**SD**	**Mean**	**SD**	
Experimental Group (AutoCAD)	89	22.833	8.790	29.451	3.996	6.818
Control Group (DTM)	71	22.940	3.143	28.818	2.930	5.874

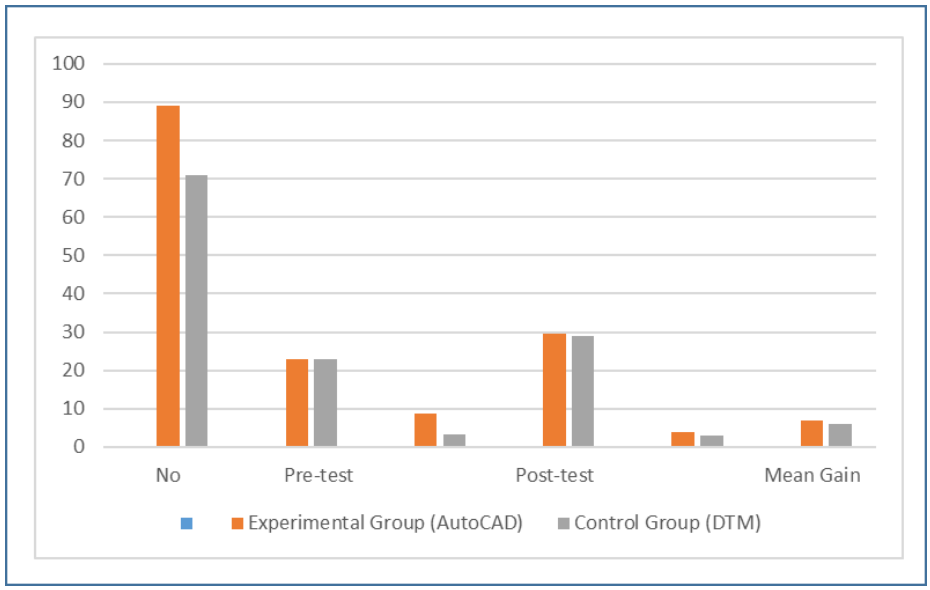

Figure 1: A Bar Chart Showing the Mean Scores and Standard Deviation for Treatment Groups Taught TD Using AutoCAD Software and with those Taught Using DTM

The data in table 1 shows that the experimental group had a mean of 22.833 and a standard deviation of 8.790 in the pretest, and a mean score of 29.451 and a standard deviation of 3.996 in the posttest gain of 6.818. The control group had a mean score of 22.940 and a standard deviation of 3.143 in the pretest and a mean score of 28.818 and a standard deviation of 2.930. The posttest and mean gain of 6.818. The result showed that the experimental group spatial ability was enhanced than the control groups. With these results, the use of AutoCAD techniques was really effective and efficient in improving students' spatial ability in technical drawing.

Research Question 2

What are the mean academic achievement scores of students taught technical drawing using AutoCAD software package with those taught using DTM?

Table 2: Mean Scores and Standard Deviation for Pre-test and Post-test Academic Achievement of Students Taught AutoCAD software and those taught with DTM

	Academic Achievement					
Groups	**No**	**Pre-test**		**Post test**		**Mean Gain**
		Mean	**SD.**	**Mean**	**SD.**	
Experimental Group (AutoCAD)	89	29.451	3.989	38.512	3.326	9.361
Control Group (DTM)	71	24.540	2.851	30.895	3.052	6.361

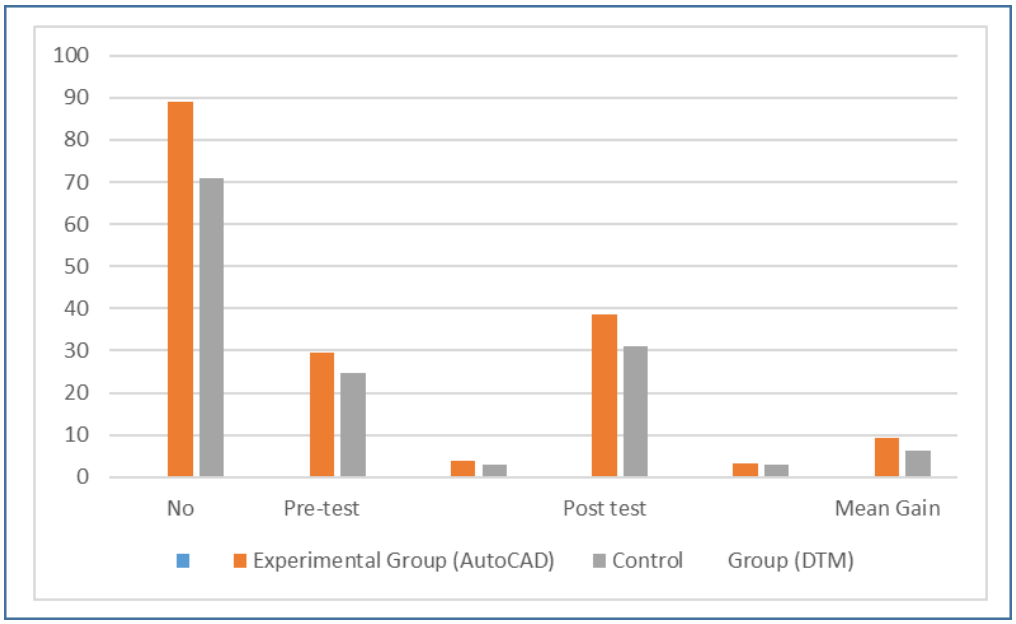

Figure 2: A Bar Chart Showing the Mean Scores and Standard Deviation for Pre-test and Post-test Academic Achievement of Students Taught TD using AutoCAD and those Taught with DTM

The data in table 1 shows that the experimental group had a mean of 29.451 and a standard deviation of 3.989 in the pretest, and a mean score of 38.512 and a standard deviation of 3.326 in the post test making a pretest – posttest gain of 5.33. The control group had a mean score of 24.540 and a standard deviation of 2.851 in the pretest and a mean score of 22.87 and a standard deviation of 3.326 .in the posttest and mean gain of 6.361. The result showed that the experimental group performed better than the control group with the pretest-posttest gain of 9.361 and 6.361 respectively.

Hypothesis 1

There is no significant difference between the mean academic achievement scores of technical colleges students taught technical drawing with AutoCAD software package with those taught using DTM.

Table 3: Summary of Analysis of Covariance (ANCOVA) for Differences in Academic Achievement of Students

Source	Type III Sum of Squares	Df	Mean Square	F-cal	Sig.
Corrected Model	591.605a	2	295.802	9.5610	.000
Intercept	3649.742	1	3649.742	117.9630	.000
Pretest	743.232	1	74.232	2.3990	126
Group	539.381	1	539.381	17.4330	.000
Error	2134.840	159	309160		
Total	45164.00	158			
Corrected Total	2726.44	160			

Significance at sig of F less 0.05

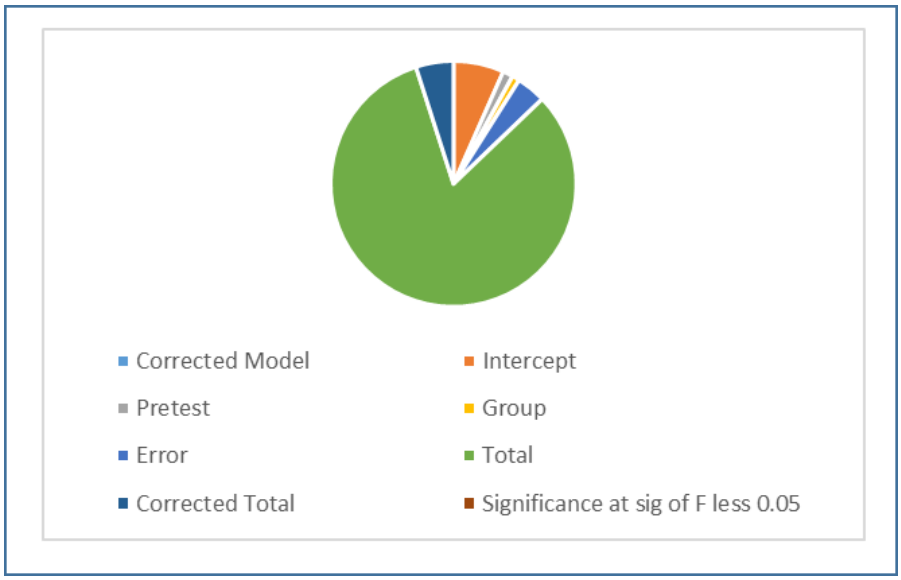

Figure 3: A Pie Chart Showing the Summary of Analysis of Covariance (ANCOVA) for Differences in Academic Achievement of Students

Table 3 shows that there is significant main effect of treatment in the post test achievement of students in the experimental and control group F-cal = 17.4330, p< 0.05. This means that there was significant difference in the mean achievement scores of students in the experimental group and the control group. The hypothesis that there is no significant mean difference in the achievement of students taught with the use of Auto CAD software package and DTM is therefore rejected. This means that the F-cal was statistically significantly at p<0.05 level. Thus, indicating that AutoCAD technique was significantly more effective than the DTM in the teaching of TD in the technical colleges in Delta State, Nigeria.

Discussion of Findings

The data presented in table 1 provided answer to research question one. Findings revealed that AutoCAD technique was effective and efficient in improving students' spatial ability in TD. The data presented in table 2 provided answer to research question two. Findings revealed that AutoCAD technique was effective in improving students' spatial ability in TD. Eze and Emili, (2013) pointed out that providing diverse learning activities could be a major source of enhancing spatial visualization ability amongst learners especially in CAD. In addition to drawing geometry with AutoCAD technique, the participants assigned to AutoCAD software package were able to solve spatial tasks by interactions with animation and virtual objects through twisting, rotating, and rolling of the virtual objects providing multi-point viewing relative to coordinate system and with the use of view point rotation that involved changing viewers angle to objects in AutoCAD space without changing the object's coordinate system, thus facilitating the visual perception and processing of objects in space. The use of coordinate system and the high degree of interaction with virtual objects and animation in the AutoCAD environment had benefited the treatment groups assigned to AutoCAD software since these features are absent in the TD. Usoro, (2010) noted that AutoCAD provided space learning environment that facilitates better understanding of spatial properties and relationships of objects and space. He explained that AutoCAD environment allows real time interactions by means of one or more control devices and involving one or more sensorial perception. In the AutoCAD environment, learners could view objects from close up or from a distance when examining specific and holistic feature of the artefacts thus concurring with Eze and Emili, (2013) studied that suggested alternating between interaction and observation was the best way to learn spatial visualization.

The data presented in table 2 provided answer to research question one, findings revealed that AutoCAD software package was effective in improving students' academic achievement in TD. The finding indicated that experimental group had higher mean scores than the control group in posttest. Although the slight superiority of the control group over the experimental group in the pretests could be attributed to the initial differences between the subjects in the groups. These findings that AutoCAD technique hold positive effect on students' academic achievement is in consonance with the works of Eze and Emili, (2013) who noted that impact of multi-media computer based instruction on students' comprehension of drafting principles was significantly more effective than the traditional format in academic achievement.

Table 3 revealed that the calculated F-value (17.4330), Significance of F (.000) and confidence level of 0.05 there was a statistically significant difference between the effect of treatments (AutoCAD and DTM methods) on student's achievement in TD confirming that the difference between the effect of AutoCAD and DTM was statistically significant. The implication of this finding is that AutoCAD technique is

more effective than DTM in enhancing students' achievement in TD. This finding compared favourably with the finding of a research conducted in United States by Thomas (1996) reported by Jimoh, (2010). Findings showed that the AutoCAD technique was more effective than the DTM method. Similarly, Eze and Emili, (2013).) noted that drawing in AutoCAD environment have significant communication advantages by representing form and space more realistically. AutoCAD techniques providing different perspective views to make available the user a sense of an objects' orientation in space. Thus, this result could be attributed to the fact that three physical dimensions of space-height, width and length could improve deeper understanding in geometric construction in the treatment.

Contributions to Knowledge

The findings of the study would be of immense benefit to the following groups: students, teachers, curriculum planners, future researchers, education policy makers, society and parents. For the students, the learning of TD would be more interesting and less stressful with the introduction of AutoCAD software. The findings of the study would impact positively on graduates in the sense that they will use effectively utilized AutoCAD software to draft out shapes and machines components. Graduates would match current global demand in education

For teachers, it would be a more effective means of giving instruction. Assessment would be simpler with the introduction of this new system. It saves energy as the use of drawing instrument to illustrate examples will not be difficult. All demonstrations are done by just controlled the mouse. Explanation of solid geometric problems and nature of shapes could be exhibited using different tools provide in the AutoCAD icons such as Home, Insert, Annotate, Parametric, View, Manage, Output, Add-ins, Express tools and Features App and like. The knowledge gathered in this work would enable curriculum planners and technical and vocational education stakeholders such as NBTE has recommended the integration of AutoCAD software package into the TD curriculum.

The findings of the study would have substantial benefit to the future researchers in the sense that it would provide empirical data for future research in related or allied professions; which could as well contribute significantly to their knowledge in TD with AutoCAD. The knowledge of the findings of the study, would greatly help the Ministry of Education in the procurement of ICT equipment for effective and efficient teaching and learning in technical colleges, and also provide modalities to improve teaching and learning in technical colleges.

For industries, more students would be interested in offering engineering courses in tertiary institutions leading to more manpower in the industries and thereby promoting National Development. Therefore, it is pertinent that the TD teachers should make adequate use of the AutoCAD software as instructional tool in teaching in order to sustain the students' interest and engagement.

Finally, the findings of this study would bring relief to parents as their children would become skillful in technical drawing with AutoCAD who would secure gainful employments in industries and also be entrepreneurs. Thus, the standard of living would improve among the people as well as the nation's economy.

Conclusion and Recommendations

Based on the findings of the study, it was concluded that AutoCAD software package was an innovative, effective and efficient method of improving students' spatial capability and academic achievement in TD in technical colleges. This implies that students learnt better when they are exposed to computers, videogames, digital music players, video cams, cell phones, and all the other modern technological toys and tools. Therefore, the use of AutoCAD should be integrated into teaching and learning of TD in technical colleges because CAD drawings are faster, better and more accurate than manually drafted counterparts using drawing instruments.

Recommendations

Based on the findings of the study, the following recommendations are made:

i. AutoCAD should be incorporated by curriculum planners into the teaching of TD to enhance students' spatial ability and good academic achievement in the subject.
ii. TD teachers should embrace the innovative approach offered by AutoCAD software package by embarking on self-updating, so as to make them relevant in this present technology era.
iii. The Ministry of Education should make provisions to train and re-train TD teachers on ICT training programme on regular basis, so as to equip them in latest technology software in the teaching of TD.
iv. When the teachers are motivated by way of training to meet the latest trend in the graphics technology they will be able to impact same to the learners.

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