COMPARATIVE EFFECTS OF 2D AND 3D METHODS OF GRAPHICS IN AUTOCAD ON INTEREST OF NATIONAL DIPLOMA STUDENTS IN ENGINEERING GRAPHICS IN SOUTH-WEST NIGERIA

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Abstract
This study determined comparative effects of 2D and 3D methods of graphics in AutoCAD on National Diploma students' interest in engineering graphics. The study was a pretest, posttest, non-equivalent control group quasi-experiment which involved groups of students in their intact classes assigned to treatment groups. Two research questions and three hypotheses, tested at 0.05 level of significance, guided the study. The sample size was 227 ND I mechanical engineering students in the polytechnics in the south-west geo-political zone of Nigeria. The instrument used for data collection was Engineering Graphics Interest Inventory. Mean, standard deviation and ANCOVA were used to analyze the data collected. The study found AutoCAD 3D method more effective in improving students' interest in engineering graphics than AutoCAD 2D method but the effect was not found statistically significant. There was no significant influence of gender on students' interest in engineering graphics. The study found no significant interaction effect of treatment and gender on interest of National Diploma students in engineering graphics. Hence, irrespective of nature of gender, learners will record improved interest in engineering graphics when AutoCAD 3D method is employed for teaching.

Keywords: *AutoCAD techniques, National Diploma Students, Engineering Graphics, Computer-Aided Design (CAD)*

Introduction

Interest plays an important role in learning and therefore its effects are frequently emphasized in various fields of education. In educational practices, students' interest is linked to achievement with particular subject content such as engineering graphics. Interest refers to a psychological state of having an affective reaction to and focused attention for particular content and/or the relatively enduring predisposition to re-engage particular classes of objects, events, or ideas (Renninger & Suzanne, 2002). It is an emotionally oriented behavioural trait which determines a student's vim and vigour in tackling educational programmes or other activities. In the 21st century, learning with computer technology has become essential in schools. Computer technology being used as both tool and method is effective for improving students' attention in learning, interest and achievement. Additionally, computer technology makes learning clearer, and more lasting. So especially for teaching visual concept like engineering graphics, it is very important to use visual materials for students to understand the concepts in engineering graphics and improving students' interest towards learning.

Engineering graphics deals with construction of different geometric figures and shapes, orthographic projections, orientation of objects in space, development of objects and intersections of regular solids and planes (National Board for Technical Education (NBTE), 2003). Nowadays, students are growing with visual tools like television, video, animation, computer and internet. It is therefore impossible to get these students' interest and give permanent knowledge with traditional methods of teaching such as demonstration and lecture methods predominantly used in the past to teach engineering graphics to the National diploma students

studying mechanical engineering in the polytechnics in Nigeria. Hence, the usage of Computer Aided Design (CAD) package such as AutoCAD has become inevitable to teach engineering graphics.

AutoCAD is an interactive drafting software package developed in the early 1980s by Autodesk incorporation for construction of objects on a graphics display screen. The use of CAD package such as AutoCAD improves the creative thinking skills of students by providing them with effective communication, presentation skills, and evaluation tools (Iyendo & Alibaba, 2015; Olukoya & Kuti, 2015). Construction of geometric objects in AutoCAD are guided by the use of AutoCAD command prompt which provides human and computer interface that enhances students' interaction with the learning environment. Planned students' interactions with learning environment are the most critical components of any learning environment, particularly, computer-based learning and are known to have a positive effect on students' learning, engage students in the learning tasks, and helping to sustain students' interest and improve students' achievement in learning.

Geometric construction in AutoCAD relies heavily on the understanding of the Cartesian Coordinate Systems; two dimensional (2D) and three dimensional (3D) and the ability to relate them to objects in space. According to Bertoline & Wiebe (2005) coordinate geometry based on Cartesian systems theorize that for every point in space, a set of real numbers can be assigned, and for each set of real numbers, there is a unique point in space. The 2D method of graphics in AutoCAD locates the points of geometric forms in AutoCAD 2D space using combination of absolute coordinate (x,y), relative coordinate (@x,y) and polar coordinate (@distance, angle). The 3D Method in AutoCAD on the other hand, locates the points of geometric forms in 3D space using absolute coordinate (x,y,z), relative coordinate (@x,y,z), spherical coordinate (@ distance < angle < angle) and cylindrical coordinate (@distance < angle, distance) (Bertoline & Wiebe, 2005; Finkelstein, 2002). These two methods can be used to construct the same type of objects in AutoCAD environment.

As computer technology is introduced into the classrooms with the focus of improving students' interaction with the learning environment, the implication of gender differences in the use of technology for learning has been extensively researched. Studies have found that using technology for learning is a dominant activity for males and that males have positive attitudes toward using technology for learning more than females (Hwang, Suk, Fisher, & Vrongistinos, 2009; Li & Kirkup, 2007). According to Burtler (2000) gender has been a consistent factor affecting computer usage based on two reasons; a cultural bias that technology is a male domain, and a perception that computer technology is linked to mathematics, a field that females feel is identified more with males. Similarly, Ferran & Bosch-Cablanch (2018) found that despite intensive use of computer by both males and females, males are favoured in computer anxiety, self-confidence and self-efficacy. Pektas & Erkip (2006) in their own study found significant gender difference in attitudes toward use of CAD tool for Design with males having more positive attitudes than females. However, some other studies found gender equivalence in computer interest, usage, and skills levels (Shaw & Giacquinta, 2000). Robinson & Amadi (2016) found no significant difference in the mean performance scores of male and female students taught electrical drafting with CAD. With the adoption of AutoCAD for teaching engineering graphics in many polytechnics in south-west Nigeria, there is dearth of empirical data on the effects of 2D and 3D methods of graphics in AutoCAD on students' interest in engineering graphics which could serve as a directive to engineering graphics lecturers and other educators. Besides gender differences may influence students' use of 2D and 3D methods in AutoCAD.

Purpose of the Study

The major purpose of this study was to determine comparative effects of 2D and 3D methods of graphics in AutoCAD on interest of National Diploma students in engineering graphics in south-west Nigeria. Specifically, the study compared the mean interest scores of students taught engineering graphics with 2D and 3D methods of Graphics in AutoCAD. The study also determined the influence of gender on interest of students taught engineering graphics with AutoCAD

Research Hypotheses

The following null hypotheses tested at .05 level of significance guided this study:

HO_1: There is no significant main effect of treatment (AutoCAD 2D and 3D) on students' interest in engineering graphics

HO_2: There is no significant influence of gender on students' interest in engineering graphics

HO_3: There is no significant interaction effect of treatment and gender on students' interest in engineering graphics.

Research Method

This study was a pretest, posttest, non-equivalent control group quasi-experiment which involved groups of students in their intact classes assigned to treatment groups. The study was conducted in NBTE accredited polytechnics offering mechanical engineering in South-West Nigeria. The sample size was 227 ND I mechanical engineering students. Non-proportionate stratified random sampling technique was used to select two Federal and two State polytechnics. Each of the Federal and State Polytechnics was randomly assigned to the treatment conditions. 108 students (98 male and 10 female) constituted the treatment group assigned to AutoCAD 2D Method, while 119 students (108 male and 11 female) constituted the treatment group assigned to AutoCAD 3D method. The instrument used for data collection was Engineering Graphics Interest Inventory developed by the researcher. The Engineering Graphics Interest Inventory was subjected to face validation by five experts. In addition, the Engineering Graphics Interest Inventory was also subjected to construct validation. In the process of construct validation, the interest inventory was administered on equivalent sample of ND1 Mechanical engineering technology students in north-central zone of Nigeria. Factor analysis technique was used to select items that attain the factor-loading standard of 0.35. Items that failed to attain the factor loading standard or loaded on more than one factor were dropped. This is because such items were factorially impure (Abonyi, 2005). Out of 40 items, a total of 28 items were finally selected. Cronbach Alpha was used to determine the internal consistency of the Engineering Graphics Interest Inventory items. The reliability coefficient computed for the Interest inventory was found to be 0.91. The data collected for the study were analyzed using Mean, to answer the research questions while ANCOVA was used to test the three hypotheses formulated to guide this study at 0.05 level of significance.

Research Procedure

Control of Extraneous Variables

Teachers' Variability:

- To reduce experimental bias, the regular engineering graphics lecturers in the participating polytechnics taught their own students. Hence, the researcher was not directly involved in administration of the research instruments and the treatment.

Teaching Guide (Lesson Plan) Preparation:

- To control variability in the development of the teaching guide (lesson plans) and to ensure uniform standard in the conduct of the research, the researchers prepared the teaching guides. Two types of Lesson plan were developed by the researcher, namely: AutoCAD 2D lesson plan and AutoCAD 3D lesson plan. The AutoCAD 2D lesson plan incorporated use of AutoCAD 2D method of graphics while AutoCAD 3D lesson plan incorporated use of AutoCAD 3D method.

Administration of Pretest

The experiment commenced with the administration of pretest to all the treatment groups. Lecturers administered the Engineering Graphics Interest Inventory to the treatment groups in their respective schools. This process provided the pretest measures on interest of the two groups before the treatment.

Treatment

The treatment group assigned to AutoCAD 2D method was taught with AutoCAD 2D method. The lecturers in the participating schools used the AutoCAD 2D lesson plans as a teaching guide. The students used AutoCAD 2D methods of graphics such as; absolute coordinate (x,y) e.g., (1,3), relative coordinate @(x,y) e.g. @(2,5) polar coordinate @ (distance<angle) e.g @(50<90), repeatedly to construct objects such as a rectangle, isometric block, ellipse, Archimedean spiral, cycloid, parabola. For example see Figure, 1, 2 and 3. In addition, the students constructed front view of isometric object in a tiled viewport using AutoCAD 2D method to specify dimensions and converted the front view to the isometric object, Figure 5, converted the object to virtual object and view the object as a virtual object. Further, the students constructed orthographic projection, section views and auxiliary views of isometric objects. The treatment group assigned to AutoCAD 2D method was taught 14 lessons. Each lesson lasted for 2 hours and the treatment lasted for 7 weeks.

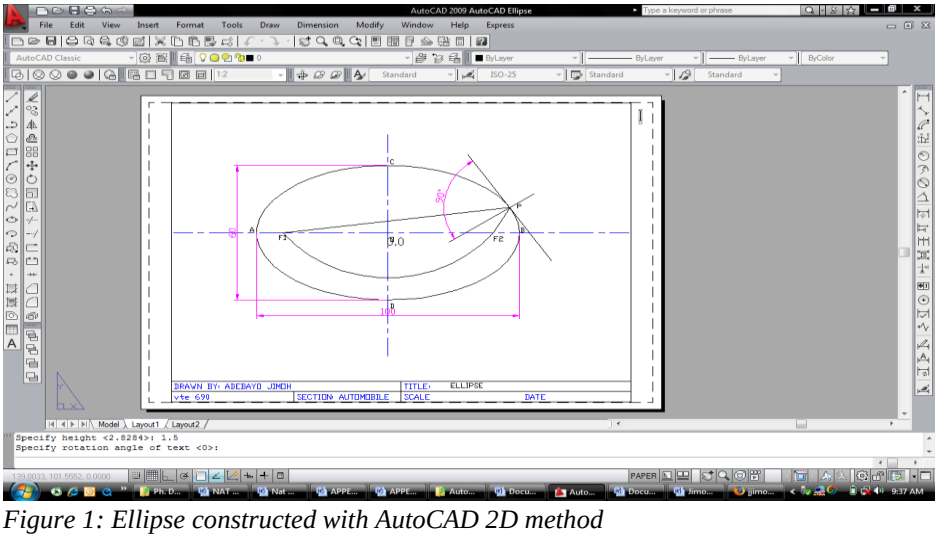

Figure 1: Ellipse constructed with AutoCAD 2D method

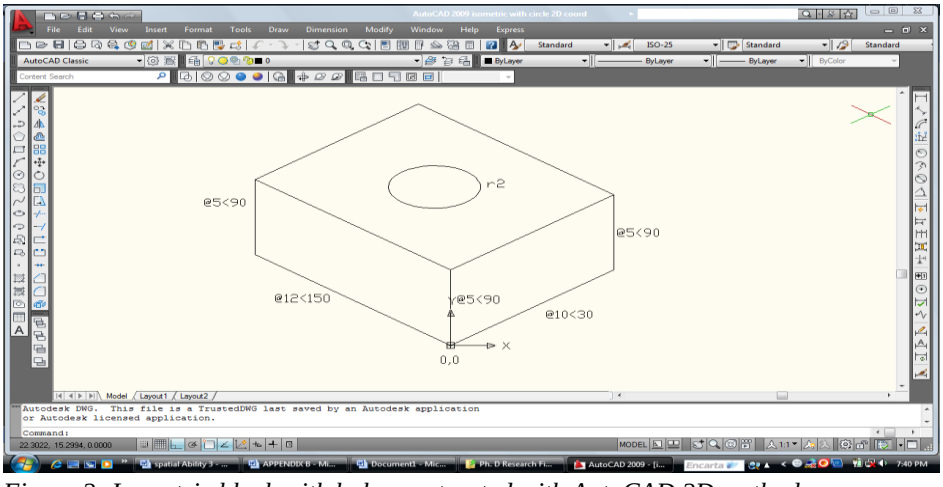

Figure 2: Isometric block with hole constructed with AutoCAD 2D method

The treatment group assigned to AutoCAD 3D method was taught with AutoCAD 3D method specifying dimensions using absolute coordinate in three-dimension (x,y,z) e.g., (1,3,4), relative coordinate @(x,y,z) e.g. @(2,5,6) Spherical Coordinate system @(distance<angle,<angle) e.g @50<60<30, repeatedly to construct rectangle, ellipse, Archimedean spiral, cycloid, parabola. In addition, the students made use of absolute, relative and spherical coordinate to construct isometric block (See Figure 4, 5, and 6). The students also constructed orthographic projection, section views and Auxiliary views of isometric objects. Furthermore, the students constructed front view of an isometric object in a tiled viewport using AutoCAD 3D method to specify dimensions and converted the front view to the isometric object, rendered the object and view the object as a virtual object. After which the students interacted repeatedly with the virtual objects in three-dimensional space through use of animation of 3D orbit, 3D continuous orbit and rotation of view point to the objects The interactions with the use of 3D orbit, and 3D continuous orbit involved panning, twisting, rotating, and rolling of the virtual objects providing multi-point viewing relative to x,y,z coordinate system while interactions with the use view point rotation involved changing viewers' angle to object in 3D space without changing the object's coordinate system.

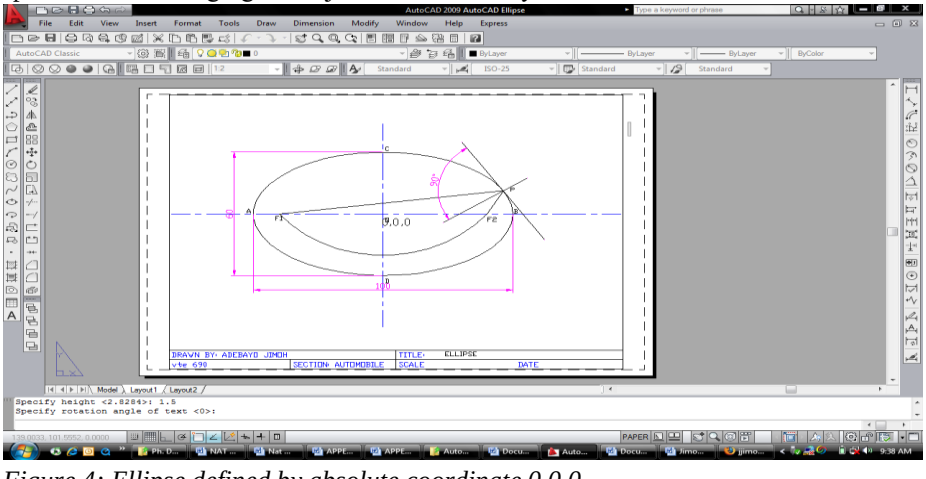

Figure 4: Ellipse defined by absolute coordinate 0,0,0

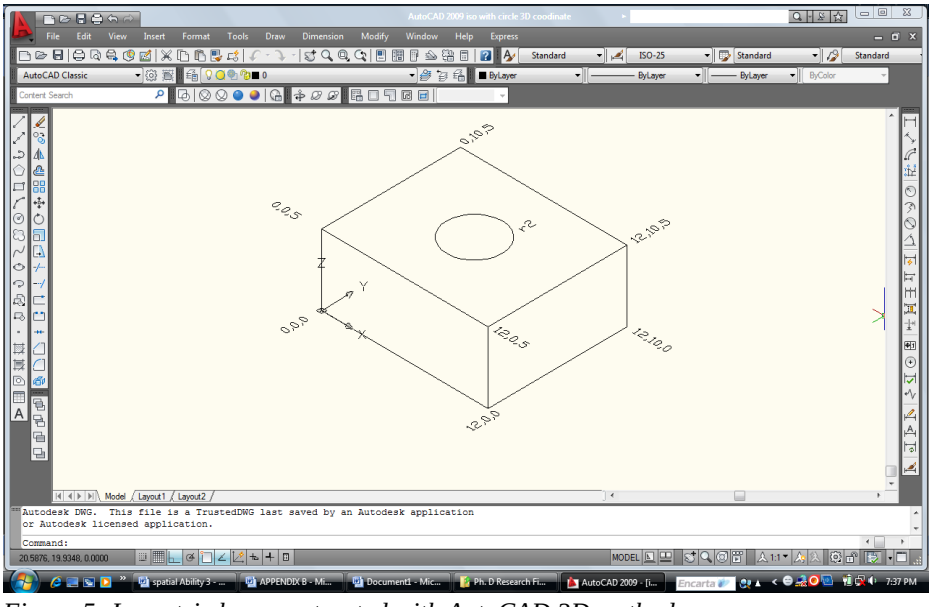

Figure 5: Isometric box constructed with AutoCAD 3D method

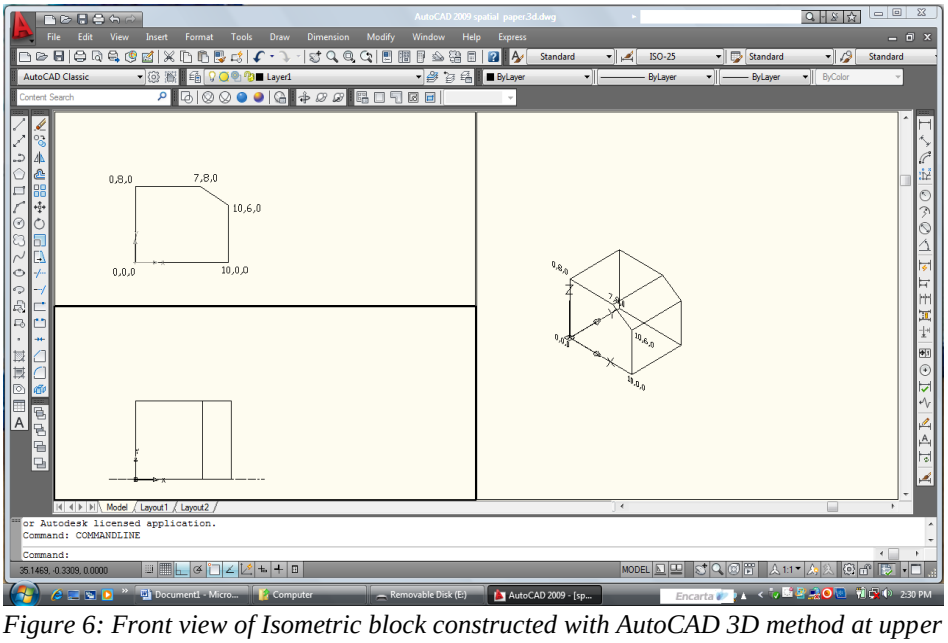

Figure 6: Front view of Isometric block constructed with AutoCAD 3D method at upper left corner

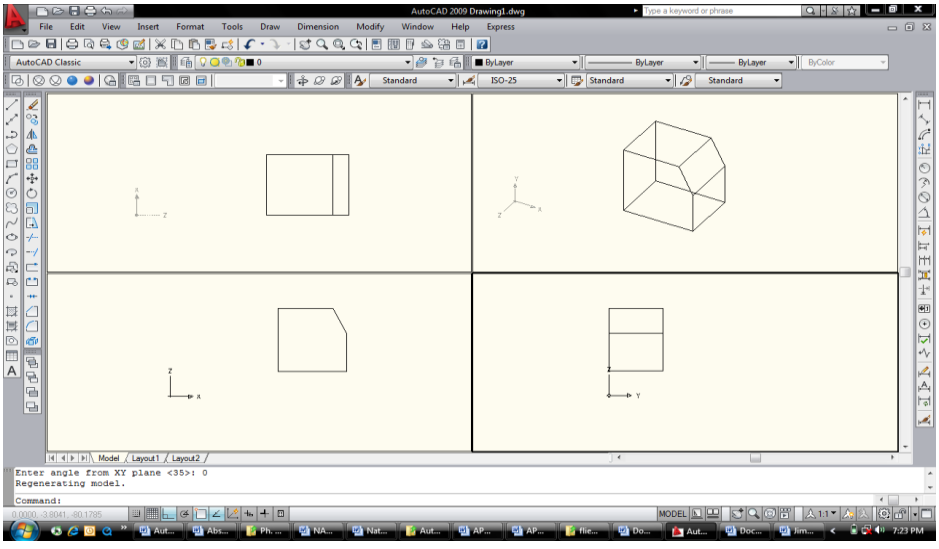

Figure 7: Top view, front view and right side view of the isometric object when rotated with Vpoint command

The students were asked to rotate View point to isometric objects, repeatedly, by responding to vpoint command. as follows: view point rotation for angle of 270 degree in **XY** plane from **X**-axis and 90 degree from **XY** plane to view the TOP view of the isometric objects. View point rotation for 270 degree in **XY** plane from **X**-axis and 0 degree from **XY** plane to view the front view of the isometric objects. View point command rotation for 0 degree in **XY** plane from **X**-axis and 0 degree from **XY** plane to view the Right Side View of the isometric objects, for example see Figure 7. The treatment group assigned to AutoCAD 3D method was also taught 14 lessons, each lesson lasted for 2 hours and the treatment also lasted for 7 weeks.

Administration of Posttest

The posttest was administered to all the treatment groups immediately after the completion of the treatment. The lecturers administered the posttest to the treatment groups in their respective schools. In the posttest, the Engineering Graphics Interest Inventory was administered on the treatment groups. This exercise provided the interest of the students after the treatment.

Result

Students' Interest after Treatment

After the treatment, the posttest mean interest score ($\overline{X}$ = 135.07 SD=2.70) of the treatment group taught engineering graphics with AutoCAD 3D method was higher than the posttest mean interest score ($\overline{X}$ = 134.14; SD= 2.78) of the treatment group taught engineering graphics with AutoCAD 2D method as shown in Table 1.

Table 1: Comparison of Mean Interest Scores of the Two Treatment Groups after Treatment

Treatment Group	**n**	**Pretest** $\overline{X}$	**SD**	**Posttest** $\overline{X}$	**SD**	**Mean Gain**
AutoCAD 2D	108	87.11	7.36	134.14	2.78	47.03
AutoCAD3D	119	87.58	7.90	135.07	2.70	47.49

Data presented in Table 1 revealed that the mean gain (47.49) of the treatment group taught engineering graphics with AutoCAD 3D method was higher than the mean gain (47.03) of the treatment group taught engineering graphics with AutoCAD 2D method. With this result, both AutoCAD 2D method and AutoCAD 3D method are effective in improving students' interest in engineering graphics but the effect of AutoCAD 3D method on students' interest in engineering graphics was higher than the effect of AutoCAD 2D method. Analysis of Covariance was used to find out significance of main effect of treatment. The result of Analysis of Covariance presented in Table 2 revealed that the difference between the mean interest scores of the treatment group taught engineering graphics with AutoCAD 2D and those taught with AutoCAD 3D after treatment was not statistically significant ($F_{1, 222} = .608$, $\rho > .05$). HO_1 was therefore accepted, confirming that there was no significant main effect of treatment on students' interest in engineering graphics. Hence, the observed difference between the mean gains in the interest of students taught engineering graphics with AutoCAD 2D and 3D methods was not statistically significant.

Table 2: Analysis of Covariance (ANCOVA) on effects of Treatment, and Gender on Students' Interest in Engineering Graphics Interest Inventory

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	91.17[a]	4	22.79	3.07	.02
Intercept	29759.003	1	29759.003	4010.65	.00
Pretest	6.36	1	6.36	0.86	0.36
Treatment	4.52	1	4.52	0.61	0.44
Gender	28.01	1	28.01	3.77	0.05
Treatment * Gender	5.30	1	5.30	0.71	0.40
Error	1648.00	222	7.42		
Total	4115896.00	227			
Corrected Total	1739.17	226			

a. R Squared = .052 (Adjusted R Squared = .035)

Effect of Gender on Students' Interest in Engineering Graphics

Table 3: Mean Interest Scores of the Treatment Groups by Gender

	Treatment Group							
	AutoCAD 2D				AutoCAD 3D			
Gender	n	Pretest	Posttest	*Mean Gain* $\overline{X}$	n	Pretest	Posttest	*Mean Gain* $\overline{X}$
Male	98	87.18	134.29	47.11	108	87.73	135.23	47.50
Female	10	86.40	133.50	47.10	11	86.18	133.45	47.27

The data presented in Table 3 revealed that male students taught engineering graphics with AutoCAD 2D method had mean gain of 47.11. Female students taught engineering graphics with AutoCAD 2D method had a mean gain of 47.10. Male students taught with AutoCAD 3D method had a mean gain of 47.50. Female students taught engineering graphics with AutoCAD 3D method had a mean gain of 47.27. With these results male students taught engineering graphics with AutoCAD methods had higher mean scores than female

students in the Engineering Graphics Interest Inventory. Thus, there was an influence of gender on the interest of students taught engineering graphics with AutoCAD methods. However, Analysis of Covariance result in Table 2 revealed that there was no statistically significant influence of gender on students' interest in engineering graphics ($F_{1, 222} = 3.773$, $\rho>.05$). This implies that the influence of gender was not statistically significant. Therefore, HO_2 was accepted. Further, Analysis of Covariance result in Table 2 also revealed that there was no significant interaction effect of treatment and gender on students' interest in engineering graphics ($F_{1, 222} = .714$, $\rho>.05$). Hence, HO_3 was accepted

Discussion

Result of Analysis of Covariance in this study revealed that prior to the conduct of this experiment there was no significant difference in the pretest mean interest scores of students taught engineering graphics using AutoCAD 2D method and those taught using the AutoCAD 3D method. After the treatment, result of the study revealed that both AutoCAD 2D and AutoCAD 3D methods are effective in improving students interest in engineering graphics but the effect of AutoCAD 3D method on students' interest in engineering graphics was higher than the effect of AutoCAD 2D method. However, Analysis of Covariance result revealed that difference between the mean interest scores of the treatment group taught engineering graphics with AutoCAD 2D and those taught with AutoCAD 3D after treatment was not statistically significant. Thus, the difference between the effects of AutoCAD 3D method and AutoCAD 2D method on students' interest in engineering graphics was not found statistically significant. Interestingly, providing opportunities for students to interact with course material through the use of computers and information technology tends to change the course from a competitive endeavour to one that is more student-centred, and focused on the cognitive development and construction of knowledge in the students (Brewer, 2003). Creating support for knowledge construction within the students is a critical component to the success of developing self-motivated, intellectually stimulated learners. One of the roles of a teacher is the use of good teaching method in the classroom. Another important role of the teacher is to order and structure the learning environment. Included in this role are all the decisions and actions required of the teacher to maintain order in the classroom such as laying down rules and procedures for learning and use of motivational techniques to secure and sustain the attention and interest of the learner (Moore, 1998). Students' interest and achievement in any learning activity is sustained by the active involvement of the learners in all aspect of the learning process and interaction of the students with the learning environment (Ogwo & Oranu 2006; Ngwoke 2004).

Furthermore, another salient finding from this study is that male students taught engineering graphics with AutoCAD methods had higher mean scores than female students in the Engineering Graphics Interest Inventory, revealing that there was an influence attributable to gender on the interest of engineering graphics students. However, there was no significant influence of gender on students' interest in engineering graphics, which implies that the influence of gender was not statistically significant. This means that the observed difference in the mean interest scores of male and female students was not statistically significant. This finding is consistent with the findings of Shaw & Giacquinta (2000) who found gender equivalence in computer interest, usage, and skills levels. Similarly, Robinson & Amadi (2016) found no significant difference in the mean performance scores of male and female students taught electrical drafting with CAD. This study also found that there was no significant interaction effect of treatment and gender on students' interest in engineering graphics. This implies that the effectiveness of AutoCAD methods on students' interest in engineering graphics does not depend on levels of gender.

Conclusions and Recommendations

Interest is an important component in learning activities, and it affects all fields of education. Appropriate teaching methods that motivate students and sustain students' interest result in effective learning. As AutoCAD is introduced into the classrooms to teach graphics concepts, the need to find the best method of AutoCAD that will sustain students' interest to learn engineering graphics is paramount. This study found out that AutoCAD 3D method was more effective in improving students' interest in engineering graphics than AutoCAD 2D technique but the mean difference was not found statistically significant. Also, the study revealed that, although, mean interest score of male students taught with AutoCAD methods of graphics was higher than the mean interest score of female students. However, there was no significant influence of gender on students' interest in engineering graphics. The study found no significant interaction effect of treatment and gender on interest of National Diploma students in engineering graphics. This simply means that the effectiveness of AutoCAD methods on students' interest in engineering graphics does not depend on the levels of gender. Hence, irrespective of nature of gender, students will record improved interest in engineering graphics when AutoCAD 3D method of graphics is employed for teaching.

References

Abonyi, S. O. (2005). Instrumentation in education research. In Ezeh, D. N. (Ed). *What to Write and How to Write.* Enugu: Pearls and Gold.

Bertoline, G. R., & Wiebe, E. N. (2005). *Fundamentals of graphics communication (4th Ed*.). New York: McGraw-Hill

Brewer, C. (2003). Computer in the classroom: How information technology can improve conservation education. Retrieved March 22, 2007, from *http://www.ibscre.dbs.ur.nt.edu/publication/Brewer-conBioarticle.pdf*

Burtler, D. (2000). Gender, Girl and Computer Technology: what's the status now? Retrieved March 1, 2019, *https://www.jstor.org/stable/30189551*

Demmert, G. W. (2001), Improving Academic Performance among native American Students: A Review of the Research Literature. Retrieved March 20, 2006 from *http://www.aor.com/pdf*

Ferran, X. C. & Bosch-Cablanch, X. (2018). Effect of intensive use of computer in secondary schools on gender difference in attitude towards ICT: a systematic Review. *Education and Information Technologies*, 23(5), 2111-2139

Finkelstein, E. (2002). *AutoCAD® 2002 bible*. New York: Hungry Minds

Hwang, Y., Suk., Fisher, W., & Vrongistinos, K. (2009). Calibrating a measure of gender differences in motivation for learning technology. *Journal of Instructional Psychology, 36*(3), 259-272.

Iyendo, T. O. & Alibaba, H. Z. (2015): Computer aided design (CAD) technology versus students' learning in architectural design pedagogy – A controversial topic review. *International Journal of Development Research*, 5(1), 3152-3158

Li, N., & Kirkup, G. (2007). Gender and cultural differences in internet use: A study of China and the UK. *Computers & Education, 48*(2), 301.

Mackenzie, D. S., & Jansen, D. G. (2005). Impact of multimedia computer-based instruction on student comprehension of drafting principles. *Journal of Industrial Teacher Education, 35(*4*),* 61-82.

Moore, D. K. (1999). *Classroom Teaching Skills*. New York: McGraw Hill Companies.

National Board for *Technical Education (2003). Mechanical engineering curriculum and course specification. National Board for Technical Education*, kaduna, Revised Curricular for Technical Colleges and Polytechnics. Kaduna: NBTE

Ngwoke, D. U. (2004). *School Learning theories and applications*. Enugu: Magnet Business Enterprise.

Ogwo, B. A. & Oranu, R. N. (2006*). Methodology in informal and nonformal technical/vocational educatio*n. Nsukka: University of Nigeria press Ltd

Olukoya, O. A. P., & Kuti, O. M. (2015). Effects of the use of Computer Aoded Design (CAD) on Architecture: A quantitative approach. Retrieved February 10, 2019, from *https://www.academia.edu/16356953/Effects_of_the_Use_of_Computer_Aided_Design_CAD_on_Architecture_A_Quantitative_Approach*

Pektas, S. L. & Erkip, F (2006). attitudes of design students toward computer usage in design. Retrieved January 2, 2019 from *https://www.researchgate.net/publication/226523177*

Renninger, K. N. & Suzanne, H (2002). students interest and achievement: developmental issue raised by a case study. February 10, 2019, from *http://cachescan.bcub.ro/e-book/580736/pag_173-220.pdf*

Robinson, R. N. & Amadi, A. I. (2016). Effect of computer Aided Design (CAD) in teaching electrical drafting in Technical Colleges in River State of Nigeria. Retrieved January 2, 2019 from*http://www.journalrepository.org/media/journals/BJAST_5/2015/sep/Robinson1212015BJAST19221.pdf*

Shaw, F. S., & Giacquinta, J. B. (2000). A survey of graduate students as end users of computer technology: New roles for the faculty. *Information Technology, Learning, and Performance Journal, 18* (1), 21-39.