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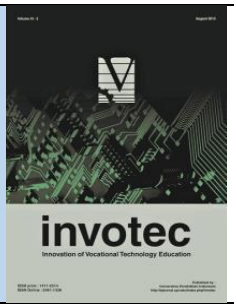

IMPROVING ARCHITECTURAL DRAWING STUDENTS' ACHIEVEMENT BY COALESCING COMPUTER-AIDED DESIGN WITH THE COMPASS METHOD

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A B S T R A C T

This study combined computer-aided design with compass approaches, employing quasi-experimental design pre-test, post-test, and a non-equivalent control group, to improve the cognitive performance of architectural drawing students. The study addressed three objectives and investigated three null hypotheses. Thestudy's target audience was 125 senior secondary year two architectural drawing students. The experimental group received ten weeks of training using the marker board compass approach, while the control group received ten weeks of instruction using computer-aided design. Data was collected using the Architectural Drawing Achievement Test, which has a reliability rate of 0.86 using Kuder-Richardson 21. Three experts validated the test's face and content. The results revealed that the experimental group's students performed more effectively at architectural drawing than those in the control group. The cognitive achievement of students is significantly influenced by gender, favouring males. Additionally, in the area of architectural drawing, high-achievers students outperformed lowachievers students by barely. Based on these results, it was suggested that senior secondary schools in Nigeria teach architectural drawing using a combination of computer-aided design and the compass method.

1. Introduction

The applications of digital technology change the cognitive and practical foundations of man. Every aspect of our daily lives is impacted by technology, which also alters our perceptions of the world. At the moment, technology is used to provide strong tools for creating, simulating, and producing architectural practices. As expressive signs are manifested through reconceiving, rethinking, contemplating, and experimenting with architecture, technological tools are also potent, effective, and meaningful media for thinking about the area of their application, the projects resulting from their use, the subjects who choose to employ them, and who legitimize them (Simpson & Bester, 2017). Computer interactive programme teaching techniques are frequently used in computer-assisted instruction and have benefits over traditional ones. So, a technical drawing teacher needs to know what makes different teaching methods good and think about how new teaching methods might make it easier to teach architectural drawing.

To improve teaching outcomes, the teacher must motivate the students to do well in their studies in addition to planning lessons. The traditional architectural design studio is transformed into an experimental space that is frequently dominated by a computer lab. Lessons are now primarily prepared on computers rather than on drawing boards. Nowadays, knowing many software programmes is a requirement, which has already pushed aside traditional lessons on drawing and representational approaches. Architectural design units typically replace their drawing deliverables with CDs featuring multimedia presentations (Iyendo & Halil, 2015). One of the teaching strategies that promotes better cognitive development and enhances student learning performance is computer-aided design (Olabiyi et al., 2016). The term "computer-aided design" describes the use of computers to produce graphic representations of actual objects. Computer software is used in computer-aided design to produce drawings. It consists of peripherals that the applications are developed for as well as hardware, specialized software (depending on the specific area of application), and other components (Olabiyi, 2020). Computers are used by CAD to generate information that facilitates the manufacture of goods.

However, because CAD does not always entail designing, this is also referred to as computer-aided drafting. These procedures, when combined, constituteComputer-Aided Design and Drafting (CADD). The programme that employs graphics for product representation, databases to store the product model, and pushing devices for product presentation is at the heart of a CAD system. Its application, however, does not affect the type of design process. Still, as the name implies, it assists the product designer, and the designer is the primary actor throughout the process, from problem discovery through implementation. In recent years, CAD has been used to create technical drawings. In place of ink and paper, the computer automatically records equivalent information. The application of CAD had a huge impact. The use of organic shapes and complex geometry in teaching technical drawings reduces repetition because complex elements can be copied, reproduced, and stored for future use; errors are also corrected; and the speed of draught allows many permutations to be tried before the final design (Wozniak, 2016).

Two-dimensional (2D) and three-dimensional (3D) computer-aided design systems are the two kinds that are used to teach architectural drawing (3D). Instead of drawing on paper and ink, two-dimensional systems like Auto CAD or Micro Station are used. The two-dimension approach described in Bertoline et al. (2002) enables the modification of a replica of the original while saving a significant amount of time. Two-dimensional systems can be used to create building designs for massive projects, but they do not offer a way to verify how each component lines up with the others. The software creates the orthographic, projected, and sectional geometry of the parts in three-dimensional systems like Auto Desk Inventor or Solid Works. Individual components can be assembled to depict the finished product in three dimensions. Buildings, ships, planes, and automobiles are modelled and examined in three dimensions using CAD systems 2 and 3 for architectural drawings before the drawings are manufactured Wozniak (2016) opined that one of the benefits of computer-aided design is the ability to add complementary multimedia experiences that are meant to make viewers feel emotional reactions.

According to Gaffikin et al. (2010), architectural drawings are frequently viewed as conventional signs and as works of art. Architecture affects every aspect of our lives. The way we live together is highly influenced by both the architectural conditions and the results of our daily lives. Being able to cross disciplinary barriers and combine many expectations and points of view into a meaningful synthesis is necessary for architecture. The technique is used to meet practical and communication needs, thus achieving utilitarian and aesthetic goals. Architectural drawing is an element of technical drawing that is related to studying, designing, and drawing building plans as well as civil engineering structures. To create it , there is a constant merging of concepts. To provide the most gratifying design, ideas are continuously integrated. Architectural drawings are used by architects, teachers, interior designers, product designers, construction workers, plumbers, electricians, and anyone who builds or creates objects for a variety of reasons, including developing a design idea into a coherent proposal, communicating ideas and concepts, persuading clients of a design's merits, enabling a building contractor to construct, as a record of the completed work, and making a record of a building that already exists (Byrnes, 2007).

Architectural designs typically follow norms and contain specific viewpoints (floor plans, sections, elevations, and details, among others). Technical drawings used to specify building structure requirements include architectural drawings. A contractor or engineer can establish the geometric aspects of a building structure as needed and develop them to indicate how the component will be erected, integrated, or connected using an architectural drawing, which typically serves this purpose. Planning, designing, and constructing buildings, bridges, and other physical structures are all part of architectural drawing. Buildings are examples of architectural works that are frequently regarded as both cultural icons and artistic creations. Architectural drawing in schools, according to Iyendo and Halil (2015), is about assisting beginning students, in particular, to explain things as precisely as possible using a pictorial depiction of things and the concept of whatever is planned for production; but, if they have to duplicate what they see by hand, they begin to understand the complexities of a building and its elements. Depth and shadow are created by the depth of a wall, the lines of a window frame or a soldier-course reveal. Olabiyi et al. (2018) say that students would have many chances to practise drawing and making real models.

Since drawing has its own language, visual style, shorthand, and convention, drawing is much more than just knowing how to draw. By utilizing well-known symbols, viewpoints, units of measurement, notation systems, visual styles, and page layout, it will be simpler to teach architectural drawings (Van Assche et al., 2013). These rules also serve as a visual language that makes sketching relatively simple to comprehend. Technical drawings serve as a worldwide tool for conveying difficult mechanical concepts because of the standards and specifications that are universally acknowledged. When creating a functional document, conventions are crucial for clear communication. Traditionally, they were created using paper and ink or a comparable medium, and any necessary copies had to be prepared by hand. The shift in the twenty-first century from tracing paper drawings to automated so that copies function properly. Traditional methods are used to teach architectural drawing in Nigerian classrooms, from post-primary to university institutions. The ineffectiveness of group instruction, the inability to store information for later use, the inability to accommodate illustrations to support the teaching, the health risk that chalk particles pose to teachers, the fact that it makes learning uninteresting, and the fact that it is teacher-centered are just a few of the limitations of instructional delivery (Olabiyi & Awofala, 2019).

Cognitive achievement is the outcome of instruction or the extent to which a student, instructor, or institution has met its educational objectives. Examination or continuous assessment are used to assess cognitive achievement, but there is no consensus on how best to test or which component of information is knowledge, such as facts (Ward et al., 1996). Individual differences between students are determined by comparing scores on mental ability exams. Simultaneously, Olabiyi (2020) maintained that cognitive accomplishment is dependent on several aspects, including instructional methods, learning environment, learner, degree of learning, method, and learners' memory capacity, among others. Instructional methods and techniques are used by teachers to provide course materials to students and engage them in learning the curriculum's contents. These are the instruments teachers employ to carry out the assigned task (Olabiyi, 2021). If one is flawed or incorrect, the goals and objectives won't be accomplished. Modern culture needs students who can work, think critically, and make decisions. This means that the way we teach must be in line with that.

Simpson and Bester (2017) describe students' cognitive achievement in technology education as their learning outcomes, which include the knowledge, abilities, and concepts they have learned and retained throughout their academic careers both inside and outside of the classroom. The learning outcomes pertaining to vocational skills, psychological abilities, knowledge, and ideas learned for profitable work in a particular career are referred to as students' achievements in Technical Vocational Education and Training. As a result, student progress in terms of academic success and psychomotor skills—including the ability to memorize and remember, inhibit and focus attention, process information quickly, and reason spatially and causally—is important (Kaur & Sharma, 2016). Additionally, the student-centred method of teaching and learning drawing is required to enhance cognitive achievement in architectural drawing and other relevant technical education disciplines. The Nigerian educational system ought to adopt such a strategy, beginning in primary school and continuing through university. The complexity of architectural sketching has recently been greatly reduced thanks to advancements in computer-aided design (Weil, 2018). Architectural drawing includes construction drawing details and mental models of buildings.

Architectural drawing instruction is expected to be goal-oriented and student-centered. This is achieved when students are receptive and teachers favour employing suitable instructional techniques and resources. Architecture drawing instruction has made it possible for people to create and build. The research that supports teachers adopting strategies and procedures that are distinct from the usual methods is the most prominent. Activities-based cooperative learning techniques and computer-assisted instruction are some of the options (Fajola, 2000). It has been demonstrated that using these alternative methods considerably improves student performance over traditional ones (Medvidovic & Taylor, 2000). But many technical drawing instructors continue to employ the marker board/compass technique. Meanwhile, there has been a lot of interest in technical drawing over the years due to worries about cognitive achievement between men and women. Because architectural drawing students have different cognitive skills, they are likely to have different cognitive roles at work.

The subject interests of students and their choice of career are influenced by gender. According to Olabiyi and Awofala (2019), male traits include being brave, aggressive, and sparing with words, whereas female traits include being afraid, timid, gentle, dull, submissive, and talkative. According to Niiranen (2018), men are expected to complete more challenging tasks while women are viewed as feminine. Men can take classes in technical/architectural drawing, woodworking, and building technology in schools. Women, on the other hand, gravitate toward vocations like home economics, food nutrition, and home management that do not interfere with opportunities for marriage, marriage obligations, or parenthood (Yusuf & Afolabi, 2010). The purpose of the study is to determine whether computer-aided design significantly affects both boys' and girls' cognitive performance in architectural drawing. Educational academics have focused on the topic of ability levels as a factor in differing learning outcomes, in addition to gender. Ability, according to Olabiyi et al. (2016) and Stott (2015), is the capability to do or behave in a physical or mental manner. According to Olabiyi and Awofala (2019), "abilities" refer to the talents a person has acquired as a result of a certain study in a particular instructional sequence. Without taking into account their differences, students with varying degrees of ability learn in the same classroom under the same conditions (Owoh, 2016). According to research Iyendo & Halil (2015), high-ability students outperform medium and lower-ability students in certain circumstances. Different ability in the classroom is a typical phenomenon, assert Olabiyi et al. (2020). In order to determine whether different levels of ability could perform better as a result of the new instructional techniques.

Given how technology has changed the world and how it will continue to do so, stakeholders in TVET anticipate that architectural sketching will help to achieve the nation's educational and environmental goals. Numerous issues that arise throughout the subject's instruction make it difficult to achieve the goals of architectural drawing. Low levels of cognitive achievement are one of these issues. Architectural drawing student achievement over the years has been below average. At the SSCE for the past ten years, it has had the greatest failure and pass rates (2006-2016) comparable to the other senior high school core subjects. Teachers and TVET stakeholders in the civil and construction industries have been concerned about how to achieve the goals of architectural drawing. Researchers have looked into challenges impacting architectural drawing instruction and learning, but it appears that the problem of low cognitive achievement is a recurrent one and has intensified to the point where it should worry everyone interested in the country's industrial growth. It became essential to reevaluate cognitive performance in architectural drawing to provide the necessary assistance to improve the current state of the subject's teaching and learning. Even when the same teacher is teaching the whole class, there are disparities in the cognitive achievement of the pupils. The variations are due to instructional methods, student ability, gender, and school location. Due to the effects of these variables, there are gaps or disparities in cognitive achievement, which lead to low achievement that is not favourable to national development. Therefore, it ought to be decreased. As a result, the study in Lagos State combined the use of computer-aided design with compass approaches to enhance the cognitive achievement of architectural drawing students. The following research questions were answered.

1. What is the difference in mean cognitive accomplishment scores between students who are taught architectural drawing using computer-aided design and the compass method and those who are taught using the traditional method?
2. How do the mean scores of male and female students who were taught architectural drawing using computer-aided design in conjunction with the compass method differ from one another?
3. How did high and low-level ability students who were taught architectural drawing using computer-aided design in conjunction with the compass method compare on their mean achievement test scores?

The following null hypotheses were tested at a significance level of.05%.

Ho1: There is no discernible difference between students taught architectural drawing using computer-aided design software and the compass approach and those with the conventional method in terms of their mean cognitive achievement scores.

Ho2: The mean scores of male and female students who were taught architectural drawing using computer-aided design in conjunction with the compass method did not differ significantly.

Ho3: The achievement scores of high and low-level-ability students who were taught architectural drawing using computer-aided design did not significantly differ.

2. Methods

A non-randomized, non-equivalent, pre-test and post-test experimental group with a quasi-experimental design were employed in the study. Students' cognitive performance in architectural drawing was studied across two levels of independent variables (experimental and control groups), two levels of gender (male and female), and two levels of academic success (high and low). Table 1 depicts the research design layout.

Table 1. Research design

Groups	Pre-test	Treatment	Post-test
Experimental	O_1	CAD combing with the compass method	O_2
Control	O_2	marker board/Compass method	O_4

The study used public senior secondary schools in the senatorial district of Lagos West, southwest Nigeria, where teachers employ computer-aided design to teach architectural drawing. The 125 year II students participating in the architectural drawing course (78 men and 47 women) made up the population sample for the study. Five schools that have offered technical drawing in the West African Examination Council for more than ten years were chosen using the purposive sampling technique, along with the two schools that served as the control group. The schools were chosen based on their workforce and facility availability. In both the experimental and control groups, school type (public schools), and gender composition, the pre-test and post-test were given under comparable circumstances (co-educational schools). The experimental group (Computer-Aided Design combined with compass) of schools were distributed at random And the control group, which used only a marker board and compass, respectively. Achievement levels and gender (male and female) were classified into intact classes (high and low). Table 2 shows the distribution of the population.

Table 2. The distribution sample for the study

Groups	Gender		Achievement levels	
	Male	*Female*	*High*	*Low*
CAD/compass	36	18	41	35
Chalk Board/Compass	42	29	27	22

The Architectural Drawing Achievement Test (ADAT) was the tool utilized to collect data . The researcher created the instrument. The ADAT, which served as both a pre-and post-test, was composed of 45 multiple-choice questions with options A to D drawn from previous West African Examinations Council (WAEC) question papers in architectural drawing. These questions covered material from the senior secondary architectural drawing curriculum related to openings, stairs, staircases, roofs; construction details of building components; working of buildings; orthographic projections; and sectional views. At the senior secondary school level in Nigeria, the cognitive achievement of students in the topics selected based on their relevance to the construction industry is not encouraging. Two technology education lecturers at the University of Lagos, Akoka, and a technical drawing subject specialist from the West African Examinations Council (WAEC, Lagos), Nigeria, validated the first 45 ADAT items. The validation process included comparing the ADAT items to the theme and substance of the lesson plan, changing the language, and ensuring that the exam was appropriate for the intended participants. Based on expert advice and the face-validated ADAT for difficulty index and discrimination power, five questions were deleted. Items having a difficulty power of 0.4–0.6,a discrimination power of 0.2 or higher, and a distractor index of negative decimals were kept (Akinsola & Awofala, 2009). Five items were deleted, leaving the remaining 40 items for the ADAT, which was tested in the pilot test. at Federal Government College, Ijanikin, Lagos State. Using the Kuder-Richardson 21 formulas, the dependability coefficient of the ADAT instrument was 0.85. On the ADAT, each question received two points. As a result, a final score of 80 was possible. According to the table of specifications, the ADAT covered the first three levels of Bloom's taxonomy of the cognitive domain known as the lower-order cognitive domain (knowledge, understanding, and application) (Table 3). The procedure in this study can be seen in Table 4.

Table 3. Test item specifications in architectural drawing

	Topics	Level of the cognitive domain			
		Knowledge	*Comprehension*	*Application*	*Total*
1	Openings-windows, doors, arches	2	2	2	6
2	Stairs and staircases-parts and types	2	2	2	6
3	Roofs-types and parts	2	2	2	6
4	Constructional details of buildings	3	3	4	10
5	Working drawing of buildings	4	4	4	12
	Total	13	13	14	40

Table 4. Procedure

Phases	Activity
I	Two (2) lesson plans have been designed to teach the subject from the test blueprint's units. Each has ten (10) lesson plans, each lasting 80 minutes over ten weeks. The subject instructor in the experimental group created the initial lesson plan using a computer-aided design and a compass, and she used it at various points during the teaching process. The second, on the other hand, was made only to teach people how to draw buildings. It uses the marker board and compass method.
II	The study's teachers who worked with the experimental group received a one-week intensive training program. The conduct happened during school lesson periods.
III	The experimental and control groups each received an Architectural Drawing Achievement Test as a pre-test. On the basis of their accomplishment test results, two groups were compared and given the names: group A (the control group) and group B. (experimental group)
IV	In contrast to the control group, which only received instruction using a marker board and compass, the experimental group received architectural lesson plans created by the researcher using computer-aided design. The course of treatment lasted 10 weeks, with each lesson lasting 80 minutes.
V	To prevent the halo effect brought on by over-familiarity with the pretest, the reordered Architectural Drawing Achievement Test was given to both groups after the fourth phase, a self-prepared post-test.
VI	The experimental group was divided into high and low ability levels prior to treatment using end-of-session data from different schools and the results of pretests on the ADAT created by the researchers based on study topics. Students who scored an average of 50% or higher were classified as high-ability students., Students with a score of less than 50% are categorized as having low ability levels.

The collected data were analysed using descriptive and inferential statistics from the Statistical Package for the Social Sciences (SPSS) program. Hypotheses were tested using Analysis of Covariance (ANCOVA) at a 0.05 level of significant for the post-experimental difference in cognitive achievement related to treatment, between males and females, and ability levels of students.

3. Results and Discussion

To ascertain the difference in the mean cognitive accomplishment scores of students taught Architectural Drawing using computer-aided design mixed with compass methods and those with conventional methods, Tables 5 and 6 answer research question 1 and test null hypothesis 1 correspondingly. According to Table 5, the experimental group that was taught architectural drawing using computer-aided design and compass had a mean pre-test score of 13.43 (SD=1.57) and a mean post-test score of 23.89 (SD = 2.48), for a mean difference between the two tests of 10.46. Meanwhile, the control group taught architectural drawing with the compass method had a pre-test mean of 8.03 (SD = 1.76) and a post-test mean of 13.18 (SD = 2.31) with a 5.15 mean difference. The results showed that students in the experimental group outperformed those in the control group. As a result, when compared to the compass approach alone the computer-aided design method was more effective.

Using the Analysis of Covariance, as depicted in Table 6 below, additional analysis of the post-treatment achievement scores of the students in the experimental and control groups revealed that the difference in averages between the two groups was statistically significant ($F = 14.501$, $p = 0.000$). Thus, it was determined that there was a substantial difference between students who learned architectural drawing and those who learned compass technique and computer-aided design mixed with the compass method in terms of cognitive success.

Table 5. The results of statistical analysis of pre-treatment and post-treatment achievement scores based on gender.

Treatment	Gender	Post-test		Pre-test		Mean Difference	N
		Mean	*SD*	*Mean*	*SD*		
CAD combine with Compass	Male	24.72	2.54	13.44	1.73	11.28	36
	Female	22.22	1.22	13.39	1.24	8.84	18
	Total	23.89	2.48	13.43	1.57	10.46	54
Compass/Chalkboard	Male	14.48	2.07	8.21	1.92	6.27	42
	Female	11.31	0.96	7.76	1.48	3.55	29
	Total	13.18	2.31	8.03	1.76	5.15	71
Total	Male	19.21	5.63	10.63	3.19	8.58	78
	Female	15.49	5.46	9.91	3.09	5.58	47
	Total	17.81	5.83	10.36	3.16	7.45	125

Table 6. Summary of analysis of covariance of achievement in architectural drawing scores by treatment, gender, and ability levels

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3878.489[a]	5	775.698	273.990	.000	.920
Intercept	697.420	1	697.420	246.341	.000	.674
Pre-test	17.535	1	17.535	6.194	.014	.049
Methods	41.053	1	41.053	14.501	.000	.109
Gender	185.164	1	185.164	65.403	.000	.355
Levels	78.434	1	78.434	27.704	.000	.189
Error	336.903	119	2.831			
Total	43856.000	125				
Corrected Total	4215.392	124				

a. R Squared = .920 (Adjusted R Squared = .917)

Additionally, Tables 5 and 6 respond to research question 2 and test null hypothesis 2 about the disparity in mean achievement scores of male and female students who were taught architectural drawing using computer-aided design in conjunction with the compass method. In Table 5, it was shown that male students taking architectural drawing classes had mean pre-test scores of 13.44 (SD = 1.73) and post-test scores of 24.72 (SD = 2.54), for a mean difference between the two tests of 11.28. The pre-test and post-test mean differences were 8.84, indicating that male students who were taught architectural drawing performed marginally better than the female students in the post-test. In contrast, female students who were taught architectural drawing had a mean of 13.39 (SD = 1.24) in the pre-test and a mean of 22.22 (SD = 1.22) in the post-test. As a result, there can still be very modest gender differences in the achievement of male students in architectural drawing. The post-treatment achievement scores of male and female students were further analyzed using the Analysis of Covariance as shown in Table 6 above, and the results revealed that there was no statistically significant difference in the means between the two groups (F = 65.403, p = 0.000). According to the result, there is no noticeable difference between male and female students' abilities in architectural drawing.

Table 7. Results of statistical analysis of pre-treatment and post-treatment achievement score based on ability levels

Treatment	Ability levels	Post-test		Pre-test		Mean Difference	N
		Mean	*SD*	*Mean*	*SD*		
	High	23.68	2.56	13.26	1.56	10.42	68
	Low	12.88	1.85	7.92	1.86	4.96	57
	Total	17.81	5.83	10.36	3.16	7.45	125

Answers to research questions three and null hypothesis three, which compare the mean achievement test scores of high and low-level ability students instructed in architectural drawing utilizing computer-aided design combined with the compass method, are provided in Tables 6 and

7, respectively. According to Table 7, high-ability level students who were taught architectural drawing had a mean pre-test score of 13.26 (SD = 1.56) and a mean post-test score of 23.68 (SD = 2.56), for a mean difference between the two tests of 10.42. Pre-test and post-test mean differences of 7.45 showed that both high and low-ability students who were taught architectural drawing benefited from the intervention, along with high achievers. The low-ability students had a mean score of 7.92 (SD = 1.86) in the pre-test and a post-test mean of 12.88 (SD = 5.83). High and low-ability students who were taught architectural drawing benefited from treatment, with high achievers having higher mean gain scores than low achievers, as evidenced by a 7.45 mean difference between pre-test and post-testWith a mean difference of 7.45 between pre-test and post-test, high and low-ability students taught architectural drawing benefited from treatments, with high achievers obtaining significantly higher mean gain scores than low achievers.

The result shown in Table 5 responds to the first research question; the score shows that using computer-aided design and the compass approach instead of the conventional methods increased students' cognitive achievement in architectural drawing. This result confirmed past research (Wozniak, 2016; Olabiyi et al., 2018) linking the usage of computer-aided design to increased cognitive learning achievement. It is interactive, uses engaging animation, sound, and examples to teach a concept, and incorporates complementary, multisensory activities meant to elicit an emotional reaction from pupils. This maintains audience attention and enhances cognitive abilities. The traditional approach has been accused of not only emphasizing teacher engagement at the expense of student participation (Olabiyi & Awofala, 2019), but also of having a negative impact on students' academic performance. Olabiyi et al. (2018) found that students have trouble understanding the main idea. This is not because the students can't understand, but because the blackboard approach to architectural sketching has its limits. In this study, it was found that CAD was better than the compass technique at developing and improving students' cognitive skills in architectural drawing. This is because CAD gave students the chance to make presentations that were both useful and educational.

Table 7, from the analysis of covariance used to test the first hypothesis, shows that there was a statistically significant difference between the main effect of computer-aided design and the marker board/compass approach on students' cognitive achievement in architectural drawing. The calculated F-value (14.501), significant of F at (0.000), and confidence level of.05 shows that the difference between the main effect of CAD and the marker board/compass approach was statistically significant. This finding suggests that using CAD, which encourages the production of details and raises expectations of accuracy, is more effective than using a marker board and compass to improve students' cognitive achievement in architectural drawing. CAD is also used to create a variety of drawings, from working drawings to photorealistic perspective views (Owoh, 2016; Medvidovic & Taylor, 2000). This means that the CAD method is better than the compass method for raising students' cognitive achievement by a large amount.The extent of student agreement that was found after employing the compass method and computer-aided drawing was one of the newest understandings. The majority of people appeared to think that hand drawing and CAD could coexist harmoniously since they thought that sketches were an excellent way to develop ideas. The following stages of the project called for more accuracy and clarity, which the design software was better able to provide. However, it is important to note that the computer clearly prevails when it comes to architectural design.

In this study, the main effect of gender on students' cognitive performance in architectural drawing was insignificant (Table 5) This finding supports earlier research findings that boys and girls perform differently when drawing architectural designs (Nicolaidou & Philippou, 2003; Olabiyi et al., 2020; Stott, 2015; Mohamed & Waheed, 2011). Gender-based differences result from sex-role stereotypes and an individual's view of their talents (Olabiyi & Awofala, 2019). The individual's perception of their ability, as well as gender stereotypes (Olabiyi & Awofala, 2019). Gender stereotypes are used to explain inequalities in cognitive achievement (Ndirika & Ubani, 2017). Historically, architectural drawing has been considered a male-dominated domain, as evidenced by career choices and professions (Lamas, 2015; Forsyth, 2007). Studies on adolescent career development support the notion of gender intensification during middle and late adolescence, accompanied by less adaptability to stereotypes (Olabiyi et al., 2020). This type of gender-specific role assumption and assumption of gender-type interests may be to blame for the pupils' subpar performance in architectural drawing. Gender disparities are a recurring theme in academic literature, especially in architectural drawing.

The second hypothesis was also tested using the Analysis of Covariance. Table 7 reveals no significant difference in the achievement of gender (male and female) on students' cognitive achievement in architectural drawing instructed by the CAD approach at the computed F-value (65.403) and confidence level of.05 Nonetheless, both students outperformed those who used the marker board/compass approach. This result suggests that there was a gender-related influence on students' cognitive development in architectural drawing. This result is consistent with the findings of numerous other research on gender differences in students' cognitive abilities in the sciences, technology, and other sectors. For instance, research using the computer-aided design method to measure cognitive achievement revealed gender disparities that favoured men. The findings support the findings of Ogbuanya and Owoduni (2015), Ndirika and Ubani (2017), Olagunju (2001), and Mbah (2002) that there is a gender gap in mathematics and science achievement. Boys occasionally outperformed girls in academic achievement in other fields.

On vocational and technical achievement tests, men typically outperformed women, indicating that men typically have more vocational and technical skills than women. The result is comparable to Becker and Maunsaiyat's (2004) conclusion that men are more advantaged in terms of vocational-technical abilities. The findings show that men and women do not benefit equally and that gender disparity is stable and continuous. In studies where achievement gaps were evident, males often had more technical and vocational skills than females. The strong gender influence on students' performance in architectural drawing was caused by the gender effect on cognitive achievement that has been identified. Men performed better than women in technical drawing and other vocational-technical disciplines, which contributed to their increased success in architectural drawing. In this study, the major influence of students' cognitive accomplishment on the architectural drawing was non-significant (Table 5). Students with high levels of ability scored better on cognitive achievement exams on average than students with low levels of ability.

4. Conclusion

The objective of the research was to enhance architectural drawing instruction in senior secondary schools by fusing the traditional method of teaching with computer-aided design. Gender (male and female) was considered as a moderator variable that could affect the dependent variables during the research process. As demonstrated by the fact that students exposed to computer-aided design outperformed their counterparts who were taught using a marker board and compass, the computer-aided design approach is more effective in raising students' achievement and ability in architectural drawing than the marker board/compass teaching method. As a result of these findings, computer-aided design is a potential alternative to the traditional training strategy for architectural drawing. It shows that by using a computer-aided design technique in architectural drawing and other technical topics, students will graduate with the requisite abilities, improving their performance in both public and external tests. Innovative CAD-based technology appears to be the key to boosting students' cognitive achievement. It works well for teaching architectural drawing, helps students of all skill levels, and is not biassed toward either gender. Following the analysis of the report's results and their implications, the following recommendations are made: To influence the potential of computer-aided design and enhance student performance, technical drawing teachers should incorporate computer-aided design into the teaching of architectural drawing It is also suggested that workshops, seminars, and conferences be held to help technical teachers learn more about computer-aided design and improve their skills in this area.

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