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Thesis
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UNIVERSITY OF NIGERIA NSUKKA

EFFECTS OF AUTOMATED TECHNICAL DRAWING COMPUTER ASSISTED DRAFTING TECHNIQUE ON STUDENTS' ACADEMIC ACHIEVEMENT AND RETENTION IN TECHNICAL DRAWING

MARCH, 2010

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(INDUSTRIAL TECHNICAL)

THESIS SUMBITTED TO THE DEPARTMENT OF VOCATIONAL TEACHER EDUCATION UNIVERSITY OF NIGERIA NSUKKA

IN FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF DOCTOR OF PHILOSOPHY (Ph.D) DEGREE IN INDUSTRIAL TECHNICAL EDUCATION

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MARCH, 2010

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USORO, ANIEDI DANIEL, a postgraduate student of the Department of Vocational Teacher Education with registration number **PG/Ph.D/05/40193,** has satisfactorily completed the requirements for the degree of Doctor of Philosophy (Ph.D) in Industrial Technical Education. The work embodied in this Thesis is original and has not been submitted in part or in full for any degree of this or any other university.

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DEDICATION

This work is dedicated to my wife Cecil, my children: Enwongo, Goodtime, Mmenyene, Inyene, Aniekan and all hard working individuals.

ACKNOWLEDGEMENTS

The researcher is grateful to the Almighty God for offering him the opportunity to undertake this study successfully. The researcher is grateful to Dr. B.A. Ogwo and Dr. (Mrs.) T. C. Ogbuanya, his supervisors for their professional guidance, cooperation and love throughout various stages of the study.

The researcher is also grateful to Prof. M.O. Okoro, Prof. S.C.O. A. Ezeji for their comments and encouragement and to Dr. E.C. Osinem and Dr. E.O. Ede for their constructive criticism and suggestions during and after the proposal stage. And other staff of the Department of Vocational Teacher Education University of Nigeria, Nsukka is acknowledged for assisting the researcher to carry out this study successfully.

The researcher is particularly grateful to post graduate representative Dr. F.A. Okwo for his suggestion, comments and guidance, which helped to improve the quality of this work. With gratitude the researcher acknowledges CODESRIA for the offer of small grants programme for thesis writing which assisted in the speedy completion of this research.

The researcher also acknowledges with thanks, the invaluable assistance of Pastor Afuamhen Albert, and Mr. Charles Okoro for programming the final copy of the software. Also, Emem Francis, Akan Francis and Mrs Eme Udo -Ikpe, for typing the hardcopy of the work and others too numerous to be mentioned for their assistance.

The researcher remembered and does appreciate his darling wife Cecil Aniedi Usoro for her encouragement, endurance, moral, spiritual and financial support during this time of the study. Fondly remember also are the researcher's lovely children Enwongo, Goodtime, Mmeyene, Inyene, Aniekan for their endurance, perseverance and understanding in the prolonged absence and other denials to ensure the completion of this theses.

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Abstract

The study sought to determine the effects of Automated Technical Drawing Computer Assisted Drafting Technique AUTOTEDRACAD on students' academic achievement and retention in technical drawing. A quasi experimental pretest and posttest design was adopted because random selection of subject into treatment and control groups was not possible without disruption of the school programme under the study. The population of the study was 2110 technical year two students in eleven technical colleges in Akwa Ibom State. The sample comprised 240 students drawn from four technical colleges. Simple random sampling technique was employed to select the colleges with purposively sample method used to determine the experimental and the control group. The instruments used for data collection was Technical Drawing Achievement Test (TDAT) constructed by the researcher and validated by the five experts, one from the department of Technical Education, University of Uyo, one from Science Education, University of Nigeria, and three from the department of Vocational Teacher Education, University of Nigeria, Nsukka. Automated Technical Drawing Computer Assisted Drafting (AUTOTEDRACAD) lesson plan produced into software and conventional lesson plan were the instruments for treatment of the experimental and control groups. The research questions were analyzed using mean and standard deviation, while analysis of covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. The study among other things found out that there is a significant difference in academic achievement and retention of students taught with AUTOTEDRACAD technique than those taught with demonstration method. It was recommended that technical teachers should make use of AUTOTEDRACAD technique as it highlights a shift from teacher centered to an inclusive and integrated practice. It further revealed that it Improves understanding, develops creativity and promotes problem solving skills needed in construction and engineering industries.

CHAPTER 1

INTRODUCTION

Background of the Study

The rapid changes and complexity of today's world present new challenges and put new demands on the educational system. As a result of increasing industrialization in modern time, knowledge and skills in technical education become increasingly indispensable in everyday life. These needs for knowledge and skills necessitated a change to improve the preparation of technical students for functioning in the continually changing and highly demanding environment.

These needs for knowledge and skills according to Carlson (2003) brought in a replacement of a new understanding of knowledge construction and the reciprocal relationship between the teacher and the learner. In view of these needs for changes in Nigeria educational system, the Federal Republic of Nigeria (FRN, 1998) in the National Policy on Education stipulated that:-

> *Technical education is that level of education obtain at senior secondary school level designed to prepare individual to acquire practical skills, basic scientific knowledge and attitude require as craftsmen and technicians at sub professional level*.

In addition to developing student's basic scientific knowledge, skills and attitude technical education also offers a wide range of content within which her product learn to control, solve problem and modify their environment to meet defined needs. In considering education for industrial and economic changes, technical education curricula was jointly reviewed by United Nations Educational Scientific and Cultural Organization (UNESCO) and National Board for Technical Education (NBTE) in 2001 (Ogwo and Oranu 2006). This action was to update the products of technical education with relevant knowledge and skills. Accordingly, in the (FRN, 2004) technical drawing is an elective subject offered at senior secondary school level but National Board for Technical Education (NBTE) stipulated that in technical colleges, technical drawing should be taught as a trade related course and should be taken by all students in engineering trades and construction trades except catering craft practice.

Engineering trade embodies: Automobile Engineering Craft Practice, Welding and Fabrication Craft Practice, Air- conditioning and Refrigeration Mechanics Work, Mechanical Engineering Craft Practice, Electrical Installation and Maintenance Work, and Radio Television and Electrical Work, while Construction trade embodies: Blocklaying, Bricklaying and Concrete work, Painting and Decoration, Plumbing and Pipe Fitting, Machine, Carpentry and Joinery, Furniture Making and Upholstery (FRN, 2004). In technical college when students from different trade areas are exposed to learning that would take place in authentic and real world environment, Bangert-Drowns, Kulik and Kulic (2006) noted that academic achievement in these different curriculum areas is achieved. This shows that technical drawing as a trade related course in technical college must be studied by all students in the technical related areas for an improved academic achievement. One of the objectives of technical drawing as contained in the handbook published by National Institute for Educational Development (NIED, 1997) is to solve practical and technological problems through the process of communication skills which are central to designing and planning.

Accordingly, Imarluagbe (1994) enlisted methods employed by teachers to direct instruction for the acquisition of knowledge and skills to include but not limited to: demonstration, lecture, question, explanation and discussion methods. As observed by Mayer (1996) the aforementioned instructional methods applied in the classroom at most times do not deliver skills and competencies required in technical education.

Gergen (1998) supporting the above assertion by Mayer noted that these methods do not only allow students to accumulate knowledge as passive listeners but also empowered the teacher to act as a director and a transmitter of knowledge from a conduit pipe. However, Wilson (1998) and Vrinten (2002) have noted that the demonstration method of teaching technical drawing do not create high academic achievement in students. This is informed by the abstract nature of presentation of the already abstract concepts of technical drawing to the students; this abstract nature of presentation seems could not encourage the class to progress without a great deal of the teacher's intervention. As noted by Wilson (2003) a great deal of erasing and drawing time is consumed as the teacher picks up on few students' mistakes. Moreover, attitude of teachers over the technical drawing instruments is perceived as boring, non-flexible, time consuming as the students must wait for the teacher to complete the drawing and give the students eye's view on the chalkboard before the students can continue to draw.

As a number of concepts that need to be covered in technical drawing continue to increase, traditional instruction, tools and equipment fall short of accomplishing the intended objectives of technical drawing. The consequence of this is that, there is emphasis on strategies such as repeat after me and do as I do, rather than problem solving and collaborative skills which boost up retention and academic achievement (Schultz and Schultz 1992).

Unfortunately, technical drawing has been identified as one of the technical subjects in which the students' achievement has been found to be continually poor (Osuagwu 1990 and Nwoke 1993). The short-coming of this present method of teaching partly has accounted for the poor academic performance of students in technical drawing of National Business and Technical Examination Board (NABTEB) in recent years and at their workplaces after graduation (Akpan 1999 and Ukoha 2007).

This short-fall negates the overall objectives of both the technical education and technical drawing as the graduates of technical colleges could be seen roaming the streets in search of white collar job, where fewer skills are required or join a mason to be a block-carrier, join motorcycle riding or a motor park tout business. Of resent computer instructions have begun to enter the academic consciousness of the Nigerian scholar and theory of teaching and learning such as constructivism which leans itself to Computer Assisted Drafting explains:

-how learners should actively construct their own knowledge and meaning from their experiences.

- ensure learners understanding various steps that would be coherent and would make sense of them.
- prepare students for entry into and advance in the workplace.

- provide not only job skills as technical education did in the 90’s but also provide higher order thinking, problem solving and collaborative work skills (Dobbins 1999 and Writh 2001).

According to Schultz and Schultz (1992); Leahey and Harri (1993); Hawkins (1999) it is critical to develop student’s capability for self- directed learning, and self-growth as the focus in teaching has now become one guiding the learner to build on and modify their existing mental models. Experts in the field of Computer Assisted Drafting (CAD) programme such as Janessen (1994); Roth, Waszcyna and Smith (1996); Waugh (1998); Wilbury (1999); Vrinten (2002); Hurd (2002); Bixler and Bergman (2003); Pardrous and Waxman (2004) at separate findings have reported that there is a wide acceptance of Computer Assisted Drafting in the field of technology education because its features in teaching–learning situation is less tedious, less boring, saves times, less monotonous, allows for complex content and problem solving exercises. One of such possible solutions to enhance academic achievement and retention in technical drawing is to introduce Automated Technical Drawing Computer Assisted Drafting (AUTOTEDRACAD) technique in teaching technical drawing instruction.

Automated Technical Drawing Computer Assisted Drafting (AUTOTEDRACAD) is customized interactive software developed by the researcher for use with computer to present technical drawing instructions, to track learning, monitor learning that take place and direct the user to additional material which meets the students’ need. Additionally, it is a self tutored programme with less active mode of the teacher, produced on Video Compact Disc (VCD). Since it combines text, graphic, sound and video in the learning process, it is especially useful for distance learning to remediate understanding. Automated Technical Drawing Computer Assisted Drafting (AUTOTEDRACAD) has the following techniques: Sequential Instruction (SI), Multi-sensory Presentation (MP), Surface Modeling (SM), Problem Solving (PS) and Competency Based Evaluation (CBE).

Sequential instruction technique–This is a technique where the objectives of the course are sequenced according to the learning level of hierarchy, so that the instruction begins with developing knowledge and then progresses to apply that knowledge and skills to a variety of situations. This technique assists the learner to use the materials as a discovery learning resources to learn factual information, simple discrimination, rules and simple application of rules. This technique avoids unnecessary training, accommodates individual learning styles, encourages mastery learning and provides consistency in teaching and learning.

Multi-sensory presentation technique–This is the integration of text, graphic, video and sound in the learning process. The software is loaded into an individual computer system with students using it on a one to one basis as an individualized tutorial/learning system. This technique requires little if any, instructor's assistance in helping students use the product. All necessary information is contained within the software. Automated Technical Drawing Computer Assisted Drafting the instructor may occasionally explain concepts in detail as necessary. Furthermore, students have direct interaction with the software and control the pace and sequence of the instructional materials.

Surface modeling technique–This technique primarily offers product visualization so that appearance would be fully and accurately known before production began. It permits the design of 3-dimensional shapes which would be viewed on plan, and elevations. This technique attempts to model a real life object on a computer prior to production and display them on drawing paper. Surface modeling has the capacity to simulate objects with effect of various types of lighting, lights in different locations, and varying surface reflection, it is interactive and enhances recalling and retention of knowledge.

Moreover, problem solving technique gives students the opportunity to develop a plan of action for dealing with his or her problem. It is one of the most challenging techniques used in Automated Technical Drawing Computer Assisted Drafting. (AUTOTEDRACAD) programme which helps student to develop logical skills in solving problems and following directions which could ensure higher order thinking skills. This implies that the students seek out information relevant to solving the particular problem.

However, competency based evaluation technique provides opportunity for the learners to put their knowledge into practice and receive immediate feedback on their knowledge construction. At the end of each lesson of content, the computer gives question to determine whether the learner requires remedial content or was ready to go to the next section. If the answer was incorrect, more information is given to help the learner generate the answer. The training objectives outline what the learner must do in order to master the skills, and emphasis is on achieving competence-doing, all learners are expected to perform at a level of B or higher. This technique permits quantitative measurement of competencies as well as eliminating learning deficiency as it encourages mastery learning.

Retention in this study is referred to as the process of maintaining a replica of acquired new meanings or the ability to recall the piece of information whenever it is required (Mayer 2003). Also, academic achievement refers to performance of students in a school subject as designated by a score or mark in an achievement test (Artherton, 2003). He noted that academic achievement is dependent on several factors such as instructional techniques, learning environment and the learner.

With respect to academic achievement, there is a generally observed pattern of females out performing males in most subjects but less so in mathematics and sciences (Riding, Grimley, Dahraci, and Banner 2003). They noted that males have greater ability in mathematics while females have a greater ability in language and verbal skills. However, Kimura (1998) contended that boys are better than girls in spatial tasks and large motor skills. From the above contention, when method of teaching is geared towards meeting students' varying styles of learning, the gap in academic achievement between boys and girls is bridged. As more demands are put upon education in today's world of rapid technological changes, it may be important to recognize that there is need for a novel method of teaching in technical drawing . These challenges therefore, necessitate a shift from traditional approach of teacher directed to student centered approach of which AUTOTEDRACAD technique is based.

Statement of the Problem

Technical drawing has been used to communicate ideas from ancient time to this modern era. As a vernacular of industry, technical drawing is essential to the educational curriculum of technical colleges as noted by the Federal Republic of Nigeria (2004) in the National Policy of Education. One of the primary goals of technical drawing is 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 everything in the society (NIED 1997).

This construction as noted by Mackenzie and Jansen (2002) ranges from the house one lives to the computer on the desk. However, the present method of teaching technical drawing seems to make students not to retain new information and achieve academic excellence. As observed by Lohr, Ross and Morrison (1995) technical drawing instruction transmitted to the students do not follow proper sequential instruction. The lack of students' direct interaction with the software, the control of pace and sequence of instructional material according to Nwoke (1993) cannot accommodate individual learning styles thereby causing frustration and loss of interest in technical drawing course.

According to Rieber (1994) and Thurman (2000) the traditional method of demonstration in teaching technical drawing lacks surface modeling of object in various types of lighting and surface reflection prior the production. As the students are presented with complex drawing problem the traditional tools with demonstration method seems not flexible to allow students solve drawing problem in fraction of time. (Janassen, 1991).

One shot examination or four times test in a term do not test the students for required competencies in the world of works. With the traditional approach to evaluation students are not given time to remedy their assignment or test once completed and submitted (Shea 2001). Harrison (1996) asserted that optimum result could not be achieved as the traditional instructions with chalkboard and large drawing instruments offered limited utility when used by the teacher to teach difficult and complex drawing.

The limitation in the traditional method of instruction seems has failed to lay much emphasis on work skills, such as problem solving and critical thinking habits (Ross 2001). Students' poor performance in NABTEB technical drawing examination in recent years can be attributed partly to poor instructional method (Akpan 1999; Akpan 2000; and Omeji, 2001) and at workplace when employed on graduation (Gypi 1991; Harrizon 1996; Driscoll 2000; Vrinten 2002; Mackenzie and Jansen 2002 and Kulik and Kulik 2003).

All these negative trends are pointers to the fact that traditional method and tools in teaching drawing rarely produce skills employers required in today's job market. Based on the literature, Computer Assisted Drafting have been applied to the works of scholars in physics, engineering graphics, architectural designs and medical education, there arose the need to determine the effects of AUTOTEDRACAD technique on technical college year two students' academic achievement and retention in technical drawing.

Purpose of the Study

The major purpose of the study was to determine the effects of Automated Technical Drawing Computer Assisted Drafting (AUTOTEDRACAD) Technique on technical college year two students' Academic Achievement and Retention in Technical Drawing.

Specifically the study sought to:

1. Determine the effects of AUTOTEDRACAD technique on students' academic achievement in technical drawing.
2. Compare the Technical Drawing Achievement Test (TDAT) scores of students' (girls and boys) when taught with AUTOTEDRACAD Technique.
3 Determine the effects of AUTOTEDRACAD technique on students' (boys and girls) retention in the study of technical drawing
4. Determine the effects of AUTOTEDRACAD technique on students' retention in the study of technical drawing.

Research Questions:

The following research questions were formulated to guide the study.

1. What are the effects of AUTOTEDRACAD technique on students' academic achievement in technical drawing?
2. What are the effects of comparative Technical Drawing Achievement Test (TDAT) scores of students' (girls and boys) when taught with AUTOTEDRACAD Technique?
3. What are the effects of AUTOTEDRACAD technique on students' (boys and girls) retention in studying technical drawing?

4. What are the effects of AUTOTEDRACAD technique on students' retention in studying technical drawing?

Hypotheses:

The following null hypotheses were tested at 0.05 level of significance.

1. There is no significant mean difference in the achievement scores of students' taught using AUTOTEDRACAD technique and students' taught using Demonstration method in teaching technical drawing.
2. There is no significant mean difference in the achievement scores of students' in engineering trades and construction trades when taught with AUTOTEDRACAD technique.
3. There is no significant mean difference in the achievement scores of students' (girls and boys) when taught with AUTOTEDRACAD technique.
4 There is no significant interaction effect of technique (AUTOTEDRACAD) and area of specialization on students' achievement in technical drawing.
5. There is no significant mean difference in AUTOTEDRACAD technique and Demonstration method on students' retention in studying technical drawing.
6. There is no significant mean difference in AUTOTREDRACAD technique on students' (boys and girls) retention in studying technical drawing.

Significance of the Study

The present demonstration method used in teaching technical drawing seems obsolete and have made the graduates of technical college unable to generate creative skills for their survival in this age of globalization, knowledge fluidity and rapid technological changes. This research finding therefore, will benefit the students, technical teachers, educational administration, curriculum developers, and officials of state secondary and technical schools board.

The findings of the study on effects of AUTOTEDRACAD technique will benefit the students as it will be a pointer to all the necessary knowledge and skills required in technical drawing which will make them an asset to the industry. It will also equip the students with creative, reflective, adaptive, and professional skills to solve practical and technological problems.

The findings of the study if adopted will be of immense benefits to technical drawing teachers in the application of AUTOTEDRACAD technique to simplify their teaching. This will also guide them in the use of step by step procedure in technical drawing classroom for optimum academic result.

The findings of the study if adopted will also benefit educational administrators as they will appreciate the need for AUTOTEDRACAD as such, guiding them on how to make efforts to provide AUTOTEDRACAD software in the teaching and practices of technical drawing.

The curriculum experts will see the need to review technical drawing curriculum with the introduction of AUTOTEDRACAD technique of Sequential Instruction, Multi-Sensory Presentation, Surface Modeling, Problem Solving and Competency Based Evaluation. This would promote understanding in the application of graphical language used in technical drawing. Also, it will act as a pointer to the curriculum experts on variety of ways and activities that could be introduced to address the divergent retention rate of the students.

The findings of the study will benefit the official of the State Ministry of Education and the State Technical Schools Board as they would made request to the state government for the provision of AUTOTEDRACAD software in technical schools. This will provide a greater variety of ways and activities to address to diverse learning styles in the students.

Delimitation of the Study

. The study was delimited to the following topics in technical drawing: the application of drawing in the manufacturing and construction industries, lines and letterings, simple geometrical construction, basic principles of orthographic projection, dimensions, sectioning, pictorial and orthographic, auxiliary plans and elevations and the application of loci.

CHAPTER 2

REVIEW OF LITERATURE

The review of literature related in this study will be organized under the following heading:

1. Theoretical Framework.
    - Constructivism
    - Characteristics of constructivism pedagogy in teaching and learning
    - Technical education and constructivism.
2. Conceptual Framework
    - Relevance of Technical Education, Its Curriculum in Technical Colleges.
    - Technical drawing: Aims, Importance, Activities and Constraints.
    - Prevalent Procedure Employed in the Traditional Method of Teaching Technical Drawing.
    - Computer Assisted Drafting and Programme Outcome in Drafting Process.
    - Automated Technical Drawing Computer Assisted Drafting Techniques.
    - Capabilities of AUTOTEDRACAD in Teaching Technical Drawing.
    - Academic Achievement and Retention of Learning.
    - Gender Issues in Technology Education
    - The Need for Change of Methodology
3. Review of Related Empirical Studies.
4. Summary of Literature Review.

Theory of Learning: Constructivism

A theory could be said to consist of concepts, constructs, principles and propositions that serve as a body of knowledge. Camp (2001) as cited in Ogwo and Oranu (2006) defined learning theories as a set of interrelated constructs, definitions and propositions that present a rational review of phenomena by explaining or predicting relationship among those elements. They noted that theories guide practice and lead to application of knowledge to solve real-world problems. The theoretical framework upon which this study is based is the constructivism theory:

Doolittle and Camp (1999) succinctly asserted that constructivism is a technique where scientific knowledge are constructed and reconstructed by the learner based on his or her prior knowledge. This implies that constructivism is based on the reflection of one's experience and the construction of an understanding of the worlds around him. This technique could enable learners with his/her active cognitive structure, select and transform information, construct hypothesis and make decision. This implies that the teachers do not spoon feed but rather act as a guide and facilitator as the learners are active participant rather than passive listeners.

Mayer (2003) asserted that constructivism is a novel system that allows learners to apply current understanding, take note on the importance of new experiences, and judge the prior and emerging knowledge to modify that knowledge. The implication is that teaching learning situation have gradually undergone changes, these changes are evident in situation of moving away from information transmissions to knowledge construction. These changes as noted by Mayer (2003) holds that if learners construction meaning to knowledge themselves, they are more likely to retain it because such experiences come out of their social context.

Constructivism being a learning theory has its roots in both philosophy and psychology. Doolittle and Camp (1999) noted that the essential core of constructivism is that learners actively construct their own knowledge and meaning from their experiences. Philosophically, this essence relies on an epistemology that stresses subjectivism and relativism, the concept that while reality may exist separate from experience. It can also be known through experience, resulting in a personally unique reality. VonGlasserfeld (1984; 1998) proposed the following essential epistemological tenants of constructivism:

- Knowledge is not passively accumulated, but rather is the result of active cognizing by the individual.
- Cognition is an adaptive process that functions to make an individuals behaviour more viable given a particular environment.
- Cognition organizes and makes sense of one's experience, and is not a process to render an accurate presentation of reality and
- Knowing has its roots both in biological/neurological construction, and in social cultural and language – based interactions.

Thus, constructivism acknowledges the learners' roles in the personal creation of knowledge and the importance of experience. It could be noted that the individual knowledge of creation process will vary in its degree of validity as knowledge tries to form in the cognitive structure. According to

Ernest (2003) these four fundamental tenets provide the foundation for basic principles of the teaching, learning and knowing process.

As described by Doolittle and Camp (1999) the four fundamental tenets are typically divided into three broad categories:-

Cognitive constructivism by (Mayer 1996)

Social constructivism by (Vygotsky 1978, Cobb 1994) and

Radical constructivism by (Piaget, 1973 and VonGlasserfeld 1995).

Cognitive Constructivism:- This particular epistemology as emphasized by Spiro, Fettovich, Jacobson and Coulson (2002) leads to defining principles that maintain the external nature of knowledge and the belief that an independent reality exists and is knowledge then to the individual. Dole and Sinatra (1998) noted that the results of this internalization process are cognitive process and structures that accurately correspond to processes and structure that exist in the real world. Accordingly this implies that learning is focused on:

- The procedures of how what is learned is represented or symbolized in the mind and how these representations are organized within the mind (Mayer 2003).

An example of cognitive constructivist perspective of learning as noted by Janessen (2001) would include a student within a cognitive constructivist classroom being exposed to a problem solving heuristics. The student would learn to identify and define each step as well as the use of the steps in the attainment of the correct problem solution. He noted that the student will be assessed according to his or her ability. Define, describe and explain. This implies that the focus of the cognitive constructivism is the construction of mental structures that mimic and function effectively within a knowledge reality.

Radical Constructivism: Radical constructivism maintains that the defining principles of internal nature of the knowledge and the idea with external reality are present VonGlasserfeld (1996; 1998). He posited that reality is unknowable since our experience with external form is mediated by our senses and our senses are not adapted at rendering an accurate representation of the external forms. Therefore, while knowledge is constructed from experience, that which is constructed is not, in any discernible way, an accurate representation of the external world or reality (VonGlasserfeld 1995;1998) From Von's assertion, it could be deduced that internal knowledge does not match external reality, but rather it is a viable model of experience. These viable models are created within an individual influenced by the context within which an activity was experienced and relative to the accomplishment of the particular goal. Thus, according to Doolittle (1999) "knowledge is knowledge of the knower, not knowledge of the external world; improving knowledge means improving its viability. Radical constructivism summarized its concerned with construction of mental structures, construction of personal meaning, understanding of various steps to solve problem, that may not match the textbook or teacher's understanding. This implies that the students would not be seeking a correct problem solution as determined by the textbook or the teacher but rather would be seeking a viable solution that works.

Social Constructivism: social constructivism leads to defining principles that maintain the social nature of knowledge and the belief that knowledge is the result of social interaction and language usage and thus, is a shared, rather than an individual experience (Prawatt and Floden 2002). They asserted that social interaction always occurs within social cultural context, resulting in knowledge that is bound to a specific time and place. Cobb and Yackel (1999) amplified that social constructivism is more concerned with meaning than structure, noting that to solve a problem the strategy would be experienced socially through teacher-student interaction, cooperative learning groups or class discussion.

The premise is that, the strategy would be explored socially, such that group members and the teacher negotiate the meaning and application of each step as the student would attain a personal understanding of the steps. This personal understanding according to Doolittle and Camp (1999) would not be measured against the textbook or teacher, nor would the application of the strategy be designed to attain the correct problem solution. Thus the focus of social constructivism is on shared social experience and social negotiation of meaning. The implication for this premise is that AUTOTEDRACAD technique has potentials that allow students a first- hand interaction with the soft ware.

Characteristics of Constructivism Pedagogy in Teaching/Learning:

Many theorist and practitioners such as Driscoll (2000); Brooks and Brooks (2001); Seng and Heng (2002) have generated constructivist pedagogies with an array of results. However, across all three types of constructivism, eight factors have been identified as essential characteristics in constructivist pedagogy:

- Learning should take place in authentic and real-worlds environment. This implies that knowledge construction is enhanced when the experience is authentic as the individual can construct an accurate representation of the real world not a contrived world.
- Learning should involve social negotiation and mediation. This implies that knowledge can only be attained through social context and more so language is the medium through which knowledge and understanding are constructed in social situation.
- Content and skills should be made relevant to the learner. This implies that co-operative education programme in technical education emphasizes the importance of the teacher providing classroom instruction to meet the student on the job needs.
- Context and skills should be understood within the framework of the learners' prior knowledge. This implies that the teacher must understand students' prior knowledge to create effective experiences, resulting in maximal learning.
- Student should be assessed formatively, serving to inform future learning experiences. This implies that the teacher must continually assess the individual's knowledge which is a hallmark in technical education that ensures the on-going criterion-referenced evaluation until a task is mastered.
- Students should be encouraged to become Self Regulatory, Self-Medicated and Self-Aware: This implies that students must be ready to function in collaborative setting, interpret complex requirements and exhibit self-directed, self-assessing behaviour on the job.

- Teachers serve primarily as Guides and Facilitators of Learning not Instructors: This implies that the teacher is to motivate provide examples, discuss, facilitate, support, and challenge, but not to attempt to act as a knowledge conduit.
- Teacher should provide for and encourage Multiple Perspective and Representations of Content: This implies that the student understands and adaptability is increased when he or she is able to examine an experience from multiple perspectives. This creates a greater opportunity to develop a more viable model of their experiences and social interaction.

Technical Education and Constructivism:

Technical education is designed to prepare workers for skilled positions in the work place through public system of pre-employment, on the job, skill-upgrading and worker-retraining programmes. Writh (2001) noted that even in changing society and workplaces certain practices must remain central to practice in the profession. In order for technical education to meet its obligations to the society, employability and workplace skills are identified and constructed to the students.

Accordingly, Finch and Crunkilton (1999) indicated that students must be prepared to adapt to the knowledge and skills that will be needed in the future. Technical education therefore, merges the traditional need for learning core knowledge and skills with the modern emphasis on adaptability, knowledge construction and self regulatory. Grubb (1999) noted that viewing the employability and workplace approach through constructivist lens, technical education acknowledges and embraces the following concepts:

- All teaching in technical education must begin and end with an appreciation of the student understanding.
- Students must be facile with a core set of currently, accepted knowledge and skills within technical education.
- Technical knowledge and skills are dynamic, these students must have the skills necessary to adapt.
- Student's idiosyncratic understanding may lead to new discoveries, insights and adaptations.
- Goals of technical education must produce students who are occupationally self-regulated, self-medicated and self-aware individuals.

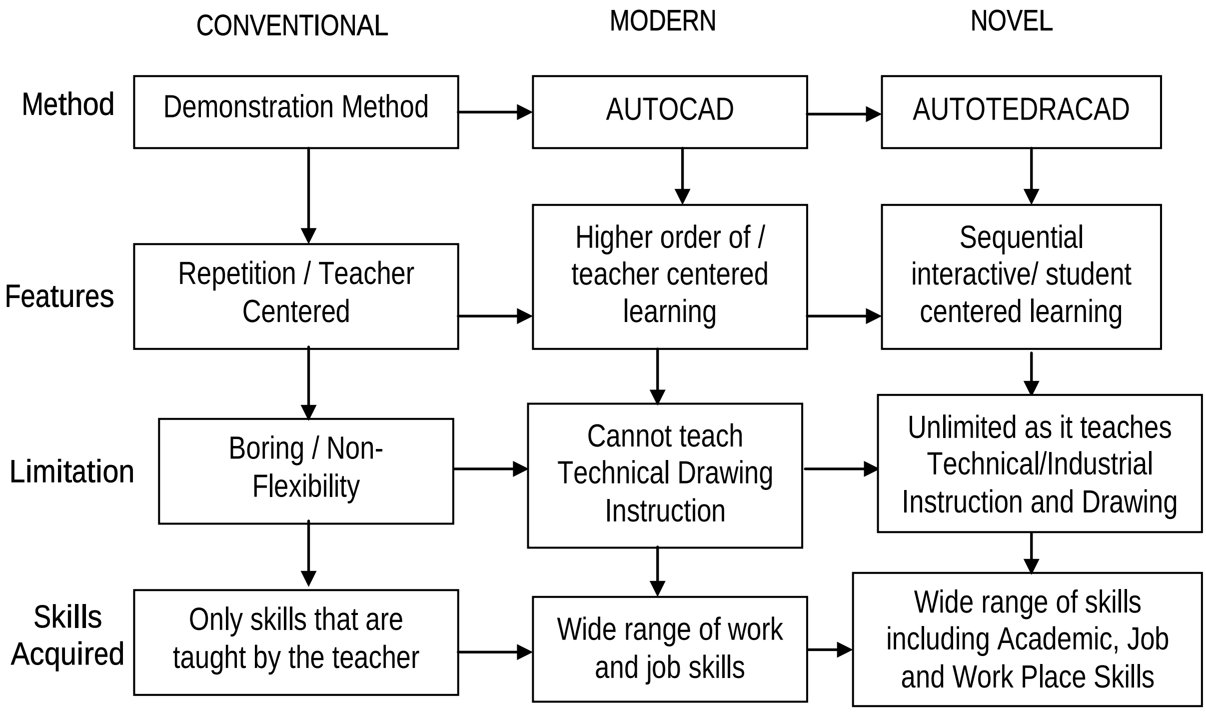
The above five concepts however provide a framework within technical education for future innovation and change in reality within which students must function effectively.

Conceptual Framework

Demonstration as a conventional method of teaching, teaches concepts, principles or real thing by combing oral explanation with the handling or manipulation of real things or equipment or materials. Okon and Ibanga (1982) noted that Demonstration method carries the imitation of the teacher's knowledge and skills and only transfer this to the recipient.

Demonstration method then seems to have the limitation that individual differences and learning styles of students would not be met as all students are expected to strive towards one goal of learning with specific knowledge and skills. To ensure a method that meet with students' varying learning style, Computer Assisted Drafting instruction was evolved. Computer Assisted Drafting (CAD) commonly refers to the actual drawing component of a project, using a computer rather than a traditional drawing board. The teachers' task in this case is to use the CAD Software to design all the relevant component part together to produce drawings and specifications which could therefore be used to estimate quantities of materials determine the cost of the project and ultimately provide the detached drawings necessary to assemble it (Vrinten, 2002).

Accordingly to Ross (2001); Vrinten (2002) and Wilson (2003) the spectrum of technical drafting projects commonly documented with Computer Assisted Drafting is broad and include: building, mechanical, electrical, structural, hydraulic, interior design, isometrics, orthographic, geometrical drawings and so on. This implies that CAD can be used to design and develop products, these are goods used by end consumers or intermediate goods used in other products. These goods are tools, machinery, a conceptual design and layout of plans. As asserted by Bangert-Drowns, Kulik and Kulik (2006) CAD enables students to acquire basic technical knowledge and skills necessary to draw plans, interpret, prepare scale pictorial and design concepts. Computer Assisted Drafting is known for a wide range of designing but has the limitation that it cannot teach Technical Drawing Instruction, hence the development of Automated Technical Drawing Computer Assisted Drafting Software (AUTOTEDRACAD). Accordingly, AUTOTEDRACAD is the training that uses a computer as the focal point for instructional delivery. It makes the training possible through the use of computer and software to supplement the conventional method of technical drafting and guides a learner through the instructional programme. AUTOTEDRACAD avoids unnecessary training and ensures consistency in training overtimes. AUTOTEDRACAD is designed to use a wide range of computer-based tools to teach basic concepts of technical drawing. It will assists technical students and teachers with other design professionals in their design activities.



Conceptual Framework of AUTOTEDRACAD

Relevance of Technical Education Curriculum in Technical Colleges

Technical education is a level of education designed to combine the exploration and development of ideas with expression in visual and material form. In addition to exploration and development of ideas with relevant knowledge and skills, technical education also offers a wide range of context within which students;

- Learn how to control or modify the environment to meet defined needs.
- Develop skill and judgment in the selection and use of resources including raw materials, technological equipment and information technology.
- Gain the ability to interpret commercial and technical ideas using a variety of media.
- Acquire a systematic approach to solving problem and making decisions.
- Develop critical thinking and the ability to evaluate the quality and effectiveness of products and systems, and;
- Develop skills in teamwork. (Scottish Consultative Council on the Curriculum, 1994).

This implies that the aims of technical education could be realized through the design, make, evaluation of sequence of processes, and development of young people's technological capabilities. If the aims are to be realized it means that students could be made to gain direct experience of the design process, involve in defining the problem to be solved and making decisions about what should be produced in achieving the solution. The premise is that the students should be involved in the production and evaluation of their instructional design. These designs are stimulating activities which develops and reinforces student's creativity, reasoning and personal skills.

According to Ogwo (2002) Curriculum of Vocational Technical Education is considered as the totality of those experiences, knowledge, skills and activities systematically planned to educate the students for gainful employment in any chosen occupation or a cluster of occupations. He noted that the curriculum is made to consist of programmes of instruction, organization and evaluation all structured to enable the students acquire knowledge and skill necessary for securing and advancing in any chosen occupation.

Mayer (2003) asserted that for an effective and efficient realization of vocational technical education objectives, the following logical steps in principles and theories technical education must be followed:

- The training environment is a replica of the working environment itself.
- The training jobs are carried on in the same way as in the occupation itself.
- The trainee is trained specifically in the manipulative habits and thinking habits required in the occupation itself.
- The training helps the trainee to capitalize his/her interest and abilities to the highest possible degree.
- The training is given to those who need it, want it and are able to profit by it.
- Adequate repetitive training experience from the occupation enables right habits of doing and thinking to the degree necessary for employment.

- The instructor in himself is a master of the skills and knowledge teaches.
- Training is carried out to the extent where it gives the trainee a productive ability with which he can secure or hold employment.
- Training is given on actual jobs and not on exercises or pseudo jobs.
- The content of the training, which is taught, is obtained from the master of the occupation.
- Training should be oriented to the manpower needs of the community.
- Vocational education at the secondary level is considered with preparation of the individual for initial entry employment.
- There is needed not to be a dualism between vocational education and general education in terms of total exclusion of one another.

Following the above principles and theories, there is a tendency to produce the desire outcome as reflected in Vocational /Technical Education curriculum. Onyeachigbulam (2004); Ogwo and Oranu (2006) asserted that the apparent failure of the institutions and low level of employment to the graduates of VTE necessitated the UNESCO and NBTE to jointly reverse the programme of these institutions. When the programme was revised technical courses in the curriculum are broadly divided into general education course, which account for 30% of the total hours required for the programme. Trade theory, trade practice and related studies which account for 65%, supervised industrial training/work experience, which account for 5% of the total hours required for the programme.

According to the FRN (2004), the general education component in the curriculum is aimed at providing the trainee with complete knowledge in secondary education while technical courses are to enhance the understanding of the machines, tools and materials of their trade and their application and as a broad concrete foundation for post-secondary (technical education) into the polytechnics, college of education (technical) or into the university.

In Nigeria, technical college is regarded as the principal vocational institution that offers full vocational training intended to prepare students for entry into various occupations (Okoro 1993). Technical colleges are established and operated by the federal government, state government and private individual (NBTE 2003).

Accordingly, the duration of programmes in technical colleges last for three years, at the expiration of the third year the students are made to enter and seat for National Technical Certificate. Federal Republic of Nigeria (2004) stipulated that the students after completion shall have three options.

- To secure employment.
- To set up their own business and become self-employed and be able to employ others.
- Pursue further education in advance craft/technical programme in polytechnics, college of education (technical) and in university.

These options are in line with the broad objectives of technical education, which is to give training and impart necessary skills. These objectives according to Ogbuanya (1999) are intended to be achieved largely through technical colleges where practical skills training are taught for the acquisition of skills for self-reliance among Nigerian youth. Accordingly, Ogwo

(2002) noted that technical teachers should realize the need for a better understanding of what method to use in teaching and learning situations as they constitute a most contributive role in student's acquisition of knowledge and skills.

Technical Drawing: Aims, Importance, Activities and Constraints

Technical drawing is a trade related practical subject with a body of knowledge aimed at securing the learner on a broader foundation on which specialized training on designing and drafting communication, construction and modeling could be based at later stage. It also provides the learners with a clearer understanding of the situation in respect of industry and assist them in becoming socially better adapted and prepared for life.

According to NIED (1997) the presentation of technical drawing at school acknowledges the need of the learner, the society and the unique nature of technical drawing. Moreover, as technical drawing knowledge and skills become indispensable in everyday life the following aims of technical drawing are reflected in the assessment objectives as articulated below.

- To encourage the acquisition of a body of knowledge applicable to solve practical and technological problems through the process of designing and planning.
- Stimulate the development of a range of communication skills, which are central to design, making and evaluation.
- Stimulate the development of a range of practical skills.

- Encourage learners to relate their work, which should demand active and experiential learning based upon the use of drawing instruments in practical areas, to their personal interest and abilities.
- To promote the development of curiosity, enquiry, initiative, ingenuity, resourcefulness and discernment.
- To encourage technological awareness, foster attitudes of co-operation and social responsibility and develop abilities to enhance the quality of the environment.
- Stimulate the exercising of value judgments of aesthetic, technical, economic and moral norms (NIED 1997; NBTE 2003).

The importance of technical drawing is aimed at inculcating practical skills, attitudes and competencies necessary for gainful employment in any recognized and emerging occupation. Saylor, Alexander and Lewis (2000) articulated the following importance of technical drawing to include:

Knowledge and understanding to the students through ability to state fact recall and describe a process and ability to apply and relate knowledge to basic designing and drawing.

- Ability to make a reasoned argument and anticipate consequences about the outcome of the design and communication process.
- Ability to demonstrate a crucial awareness of the interrelationship between design and the need of society.
- Ability to identify clearly from a problem situation, a specific need for which a solution is required and compose a design brief.
- Ability to generate a range of outline solutions to a design problem, giving constraints of time, cost, skills and resources.

- The students will be able to recognize information in one form and where necessary change it into a more applicable form.
- Propose and communicate ideas graphically.
- Develop ideas and represent details of forms, shape, construction, movement, size and structure through graphic representation.

This therefore underscores the need for technical drawing in technical school as it stresses the importance of scientific and technological literacy as stated in today's increasing technological society. Meanwhile, the subject objectives in technical drawing as noted by National Institute for Educational Development (1997) and National Board for Technical Education (2003) has clearly outlined the activities of the students to include:

- Emphasize the importance of drawing as a means of communication.
- Teach the learner to read and interpret a drawing and apply the principals of drawing.
- Develop the learners' ability to represent ideas and object graphically.
- Teach the students the correct drawing techniques and methods, which can be employed in the problem solving situations.
- Apply his knowledge in the other components of the subject, and;
- Take care of and maintain drawing and equipment Green (1975); Pickup and Parker (1984); Driscoll (1994)

This implies that technical drawing knowledge and skills are fundamental to all careers in technology education, but as may be observed technical teachers are constraints to teach these knowledge and skills to the students as teachers and students still employ absolute tools, equipment and activities in the teaching learning process (Mackenzie and Jansen 2002).

The curriculum table and module specifications in technical drawing as designed by NBTE (2003) stated that technical drawing like any often technical subject cannot be taught in abstract as the acquisition of technical drawing knowledge and skills depends on the provision of relevant equipment and tools. Ogbuanya (1999) acknowledges that, practical skills training cannot be imparted in an ordinary classroom like training for theoretical knowledge. She implies that necessary tools and equipment are needed in training for skills development and acquisition.

Supporting the above constraints in teaching practical skill subjects Wilson (2003) noted that lack of interest and motivation in students is as a result of employing traditional tools and equipment (i.e. chalkboard, still images, transparencies and manual drawing instruments). All these, he noted offer limited utility to teach difficult and complex problems coupled with traditional method of teaching.

Prevalent Procedure Employed in the Traditional Method of Teaching Technical Drawing

The instructional methods used in traditional classroom is done with manual tools such as chalkboard, drawing boards, large drawing instrument, still images and physical mock-ups NBTE (2003). According to Janessen (1994), Vrinten (2002) the following procedure are obtained in the traditional method.

- The teacher writes the topic of the lesson on the chalkboard sometimes with or without objectives.
- He discusses and explains the procedures.
- Students are expected to listen to the explained procedures.
- The drawing is made manually on the chalkboard with large drawing instrument where students are to wait until the teacher completes and displays the projected drawing.
- Students are expected to copy the drawing with or without the correct teacher's procedure.
- Students may ask questions for clarity.
- The class progresses at the pace of the faster learner, few several teachers will assist the slow learners.
- A great deal of erasing and drawing time is consumed as teachers pick up few students' mistakes.
- Ample opportunities are not given for students to practice the drawing because of the limitation of the slow process posed by the traditional instrument.
- Students are given task on drawing with or without detailed information.
- Detailed drawings are not judged objectively.

According to Smith and Regan (2003) the instruction method employed in the traditional classroom lacks cognitive strategies to ensure student's retention of facts, problem solving and adaptation. This implies that the traditional methods and the traditional tools limit extensive and variable practices, waste time, non-flexible and boring as students cannot work at their own speed. Supporting the above implication Kizzer, Ford and Pollar (2004) noted that with the traditional tools, it is difficult to solve complex and complicated drawing problem easily. Mackenzie and Jansen (2002) in their findings revealed that traditional tools lack accuracy and consistency both in appearance and in performance. In contrast, Okoro (1993) summarized that a teacher's sound level of technical knowledge and skill, adequately rich environment, adequate pedagogical technique, and a careful articulation of instructional procedures could ensure a productive outcome in students.

Computer Assisted Drafting and Programme Outcome in Drafting Process.

Computer Assisted Drafting is not limited to drafting and rendering rather it ventures into many more intellectual areas of a designer's expertise. Accordingly, Sammons (2001) asserted that CAD programme have increased their surface functionality and the high-end system which is not applicable in traditional method of drafting to include:

- Wireframe geometry creation.
- Three dimensional feature based modeling.
- Freeform surface modeling.
- Automatic design of assemblies which are collections of parts and other assemblies.
- Create engineering drawings from the solid models.
- Reuse of design components
- Ease of modification of designs of models and the production of multiple versions.
- Automatic generation of standard components of the design.

- Validation and verification of designs against specifications and design rules.
- Simulations of design without building a physical prototype.
- Output of design data directly to manufacturing facilities.
- Maintain libraries of parts and assemblies.
- Calculate mass properties of parts and assemblies
- Aid visualization with shading, rotating, hidden lines removal.
- Bi-dimensional parametric associatively (modification of any feature is reflected in all information relying on that feature).
- Kinematics, interferences and clearance checking of assemblies.
- Electrical component packaging Hose/Cable routing.
- Inclusion of programming code in a model to control and relate desired attributes of the model.
- Sophisticated visual analysis routines for drafts, curvature and curvatures continuity.

With these capabilities in CAD, it implies that Computer Assisted Drafting provides a comprehensive coverage that equips its users with the essentials drafting skills necessary for solving real world problems. The provision of the capabilities in CAD software is the hallmark of the programme outcome. According to Vrinten (2002) Computer Assisted Drafting could aid for a successful programme outcome in students in the following ways:

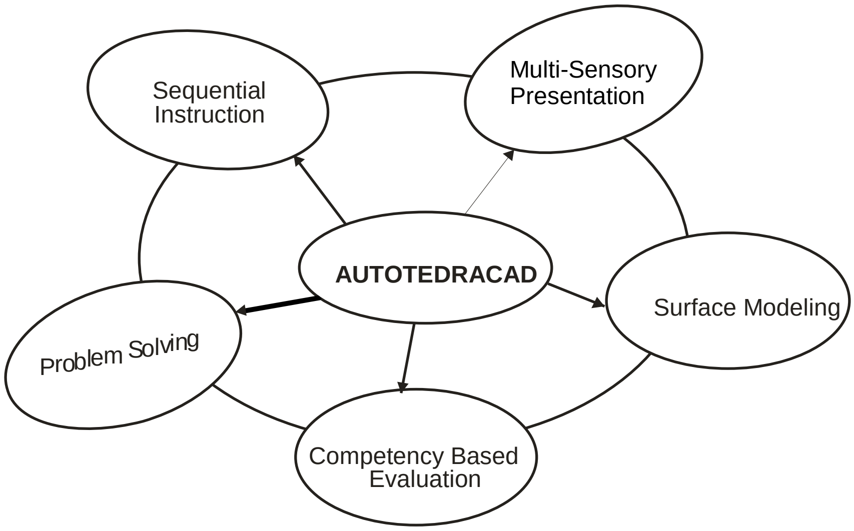
- Demonstration of skills that meet industrial standard.
- Develop professional presentation of drawings for a variety of purposes and audiences.

- Work effectively as part of a team in various professional environment and technical business.
- Display a portfolio of professional quality products to potential employers.
- Demonstrate academic skill required of all the graduates including competency in writing information, literacy, oral communication and quantitative reasoning.
- Identify career and transfer option and assume a professional role in the workplace.
- Educate students with all the necessary knowledge in technical graphics to become an asset to the industry.
- Equip students with a professional portfolio with which to launch their career.
- Assisting in securing employment for learners upon graduation.
- Allow learners the opportunities to work on actual project and competitions in their final year.
- Maintain the highest levels of professionalism within the design industry, through generation of a pool of exceptionally talented and trained learners.
- Produce caliber of learners who will be highly employable, sought after, an asset to the industry.

Furthermore, Padrous and Waxman (1994) and Driscoll (2000) asserted that Computer Assisted Drafting manifest itself in different skills and competencies, skill in this context could be said to be special abilities a student exhibits in order to seek and keep a job. Wilburg (1999) said that these skills are observable and measurable which include skills in the affective, cognitive and psychomotor domains. He noted that the derivative of the skills in the domains manifest itself in job skills, workplace skills and academic skills, while competency could be said to be a learned behaviour which can be repeated to a predetermined standard.

This implies that the manifestation of these skills and competencies as in CAD continues to promote the concept of technical drawing/drafting as a universal language of the technologist. Several experts such as Nwoke (1993); Roth Waszcyna and Smith (1997); Janessen (1994); Waugh (1998); Vrinten (2002); Hurd (2002) in a separate study concluded that there is a wide acceptance of CAD as an instruction method in the field of technology education because of its unlimited performance, image quality, interactivity, and multimedia capabilities. They asserted that when CAD is used in the teaching/learning situation, it crates fun, less tedious, less boring, saves time, less monotonous, as it allows complex content and problem solving exercise to be made easily. This implies that CAD programme is highly memorable with illustration and graphics; moreover students have direct interaction with the course materials. CAD materials could be presented to large and small group of students without the limitation of space or interference by the teacher standing in front of the chalkboard. The literature of this study according to Kulik and Kulik (2003) indicated that CAD hold promise for improving teaching and learning of technical drafting and design. It promotes and takes educational advantages of students' motivation by creating curiosity, interest, positive self-efficacy and adaptation to students varying differences. This implies that CAD is expected to be productive because of its seeming emphasis on students' motivation, interest, retention, critical thinking, interaction, high learning rate, active learning, problem solving abilities and general academic achievement.

Automated Technical Drawing Computer Assisted Drafting (AUTOTEDRACAD) Technique



Schematic Diagram of AUTOTEDRACAD

The following techniques found in AUTOTEDRACAD include: sequential instruction, multi-sensory presentation, surface modeling, problem solving and competency based evaluation. Bixler and Bergman (2003) noted that any successful classroom teaching depends primarily on the teacher's personal qualities, his professional competence, appropriateness of the teaching techniques to the age of the students, creation of positive environment in which the individual could prosper and find satisfaction, and the provision in an inherent mission to further the good of the society by contributing to its efficiency.

Sequential instruction is very useful in teaching factual information, simple discrimination, rules and simple application of rules. Vrinten (2002) asserted that it is an inherent active mode of teaching, as it causes the learner to continually do something, select a topic, and ask for a review and so on. This in contrast with the inherently passive instruction approach involved in classroom lectures, videotapes or textbooks as students learn at their own pace, individual learning style are considered and increasing students' satisfaction is ensured.

Also, Collins and Verwijs (1995) noted that sequential instruction is typically a structure that encourages the learner to follow certain instruction sequence. Since most students bring into the classroom different entry skills, progress, different rating and finish with varying amount of knowledge and achievement, sequential instruction in AUTOTEDRACAD ensures a complete set of step by step instruction, design and layout. Alternatively, the students could choose alternative sequence or use the materials as a discovery learning resources as they are so inclined. This alternative structure provides a clearer or more guidance than environment that are designed specifically for discovery learning. The implication for this premise is that this technique has within it practice exercises as well as an annotation tools that allows the learners to articulate their knowledge construction.

As Kulik and Kulik (2003); Bixler and Bergman (2003) summed it up, sequential instruction offers to the learner's consistency of training to many sets of students in terms of quality, consistent of information presented which is not available in the traditional method of teaching. Amplifying the work of Kulik and Kulik (2003); Bangert et-al (2006) noted the following prospects of sequential instruction:

- It helps the students to organize their ideas or even teach a strategy to discover ideas to write about.
- It aids in brainstorming with the outline
- It shows the tutorial discourse along with procedure.
- The tutorial identifies the work on specific aspects of the instruction.
- It focuses mainly on improving, organization, analysis, logic use of evidence and detail of other major aspect of instruction.
- It helps students to find effective and efficient ways for standard information.
- It avoids unnecessary training session.
- It avoids skipping the content.
- It ensures students learn what they need to learn as they select topic and control sequence of instruction.
- It ensures that the right concepts dominate the thinking of the students from inception of the training.

Multi-sensory presentation technique is for showing and telling how to do something, showing each step by step by actually doing it and creating the finished product which can be displayed. Bar-yam, Rhoades, Sweeny, Kaput and Bar- yam (2006) asserted that during multi-sensory presentation of a concept the computer illustrates and talks on how the objects could be constructed, drawn or model by means of a computer software. This implies that multi-sensory presentation technique could be said to be the best supported tool for the introduction of new information.

In an attempt to come in terms with these assertions, Ko and Rossen (2001) in their teaching online for a practical guide on multi-sensory presentation technique offered the following steps:

- The computer tutor speaks audibly enough so that everyone could hear.
- Show on the screen only what will lead to the achievement of the set objectives.
- The computer with the aid of the object motivates the students to watch for puzzled expression or other sign of attraction.
- The integration of text, graphics, video and sound facilitate the learning process. On the average , people remember 10% of what they read, 20% of what they hear, 30% of what they see and 50% of what they hear and see (Bixler and Bergman 2003).
- Pace your presentation according to time scheduled.

The participatory nature inherent in multi-sensory presentation technique could be said to assist students for effective communication, motivate students especially as computer carry out the presentation of a concept. Baum (2002) noted that multi-sensory presentation technique foster thinking skills. It also increases students' retention of new content knowledge, and logical reasoning. It provides real life situation of the drawing concept and also provide some measures of positive reinforcement in which case students repeat what the computer has presented. The positive implication for this premise is that students could develop positive self-concepts, engages the students in the training process, and provide increased students satisfaction.

It could be deduced that showing of how concept is achieved is much more effective way of teaching (Baum 2002).

More so, surface modeling is a technique in which the teacher creates a mock situation for students to learn about the real situation which would otherwise in the real context be too costly or dangerous and time consuming. Surface modeling technique could be said to be deceiving by actions, or gesture including modeling of a system in order to gain insight into their functioning, suffice to say surface modeling has the potentials of creating 3-dimensional computer model of object prior to production (Smith 2002).

Key issues in surface modeling according to Hartmann (2002) include the following:-

- Acquisition of valid sources of information about the referent.
- Selection of key characteristics and behaviours.
- The use of simplifying approximations and assumptions within the surface modeling.
- Validity and fidelity of the surface modeling outcome.

However, Hartmann (2002) noted that there are two major types of modeling; physical modeling which refers to modeling of physical objects as substituted for the real thing. These physical objects are often chosen because they are smaller or cheaper than the actual object or system, while surface modeling intends to model real world objects with mass and volume, noting the performance of the objects rather than its appearance. By implication when surface modeling is used in computer it becomes a useful part of modeling any natural systems in physics, chemistry, biology, human systems in economics, social science as well as in engineering to gain insight into the operation of these system.

Hartmann (2002) asserted that computer surface modeling is often used as an adjunct to, or substitution for simulation systems for which simple closed form analytic solutions are not possible. He noted that when surface modeling is used as a teaching technique, it focuses on specific task which leans itself to assess knowledge and problem-solving skills. This implies that surface modeling shares in the attempt to generate a sample of representative scenarios for a model in which a complete enumeration of all possible states would be prohibitive or impossible. It could also allow the judgment and errors to be made as students engage in the design of 3-dimensional shape of objects.

Cardenas (2000) ascertained that in surface modeling technique objects could be created in less time and with faster efficiency, as the tutor grasp the attention of the students more easily and teach multiple models that affect more than one sense (seeing, touching and hearing). It could be observed that certain instructional technique influences certain cognitive processes and for learning to occur, the instructor must learn how to incorporate these techniques into his or her teaching based on sound pedagogical principles. Rieber (1994); Thurman (2000) noted that surface modeling provides a realistic context in which learners can explore and experiment, with these exploration it allows the learner to construct their own model of the environment, see immediate result as they create models or try out their theories about the concepts.

Furthermore, problem solving technique is a basic skill in life and essential to the understanding of courses in technology education. Problem solving involves critical thinking, reasoning, logic and reasoning out solutions using more than simple application of previously learned procedures (Simon 1999). He noted that human beings are problem solvers who think and act to fuzzy out solutions.

However, Simon (1999) asserted some key issues in problem solving as it involves:

- The interaction of person's experiences and the demand of the task.
- Novel elements or new circumstances must be introduced or the level of challenge must be raised.
- Only the problem that constitutes the most profound and rewarding of humans' activities.

However, the problem solving technique is not an advanced process that is reserved solely for mature learners; indeed as noted by Simon (1999) it is for all ages to be solvers of problem. In technical education, problem solving has its major emphasis on the need to be directed towards extracting, making explicit and practicing problem-solving.

As Polya (1999) typified in his new mindset that it is possible to improve problem solving ability by recognizing the points of engaging in the problem solving. This he noted that the learner should accept as naturals, normal and expected the stepwise and discursive path toward a goal through the application of general and specific heuristics. Both teacher and the learner need to be more tolerant. If no mistakes are made, then almost certainly no problem solving is taking place. Unfortunately, one tradition of schooling is that perfect performance is often exalted as an ideal while errors are seen as failures and worst still ridiculed. Polya (1999) futher asserted that a better understanding of the nature of problem to be solved is a place to start solving the problem as a result of error or problem.

The implication is that students solve problem every time and achieve positive result without having known where the problem started. When students are given the opportunity to be directly involved in drafting and learning a task as in AUTOTEDRACAD they can set their goals, collect, arrange and evaluate the necessary data to help solve the problem. Here it could be deduced that the precise nature of knowledge and skills in technology education may have changed from repetitive, manipulative tasks to problem-solving.

Moreover, Simon (1999) identified the following steps to problem-solving that could ensure that technology education meets its obligation to society, to the education community, to business and industry and to its student-clients, these are;

- Give a few possible problem situations.
- Clarify the problem to be solved
- Ask students to suggest ways of solving the problem using past experience, insight or clues.
- Jot down tentative suggestions.
- Evaluate the advantages and disadvantages.
- Select best alternative.
- Select course of action
- Collect data

- Analyze data
- Make generalization of these suggestions.
- Compare expected result with actual result.

The implication of the above steps to problem solving in AUTOTEDRACAD classroom could be for the technical teacher to ensure the use of the under listed tips as postulated by Plooster (2000).

- Explain to students why problem solving is interesting and important.
- Rather than asking students to memorize a formula or concept, teach them how to derive the formula and identify its parts.
- Try the step by step approach to solve problem and ask small questions along the way so that students can see how the solution is being drawn and could confront similar problem with the same strategy.
- Encourage students to imagine the problem before you begin to work the solution together (this takes advantages of the skills the students already have and encourages them to actively extend their knowledge).
- State a proposed method for solving the problem rather than asking them for the solution to a problem.
- Encourage questions from the class and then avoid answering them directly. Make sure everyone hears and understands the questions and then start working on an answer as a group.
- Maintain high degree of interaction with the audience throughout the class, as the students may be willing to participate and ask questions.
- Try solving the problem in two different ways. This gives the students a sense of how best to approach a problem as it prevents mistake and hold student attention to see if the answer is the same in both cases.

- Present students with situations or design problem and encourage them to develop questions for themselves (This enables students to see how work is done at higher level in their discipline.
- Before moving on to the new concepts ask students specific questions about representative problem to test for learning.

These could be summed up that breaking down a problem into management pieces ensure a major aspect of intelligent movement toward a goal when the path to the goal is uncertain.

Competency based evaluation is a means of assessing the effectiveness of AUTOTEDRACAD techniques, enhances learning and fostering students growth in the objectives of the course of study. As AUTOTEDRACAD would be implemented in technical drawing its evaluation therefore is meant to assist teachers of technology to know whether the techniques are effectively implemented to students. According to Ehrmann (2003) evaluation emphasizes competency based teaching and learning process where the students acquired sufficient manipulative skills to perform in the real job situations. Ogwo (2002) asserted that evaluation is characterized by accountability; mastery learning, basic principles and clearly stated attainable and measurable objectives follow by identified specific knowledge and skills that learners have to master within a given time frame.

As ascertained by Watson (2004) evaluation is centered on performance- oriented activities which measure exactly within the specific content those activities required and agreed upon before and during teaching situation. He noted that the characteristic of evaluation is categorized as follows:

- the competencies to be mastered by students are role- derived, specifically stated, verified and made public.
- the contents clearly define the competencies to be mastered
- the criteria for evaluation of the competencies are made explicit through the use of the modules. Both criteria and mastery levels are made known to the students throughout the study.
- performance assessment is the major source of evidence of competency attainment.
- if the performance is not judged to be at a good or excellent level according to the criteria in the module assessment form, the students are given detail feedback and require to repeat the exercise after completing some extra activity or practice.
- the rate of progress through the porgramme is determined by demonstration of competency, not by time on course completion.
- more training time is devoted to working and evaluation each learner's ability to perform essential job skills as opposed to presenting lectures.
- the programme competencies are modularized. The modularizations of the learning materials increase the opportunities for individualizing, independent study and other alternative learning modes.

Hamilton (2002) noted that each time an implementation skill is performed the student is also expected to maintain excellent on skills developed earlier. In this way, a more holistic concept of training is developed and a more realistic presentation of a training episode is accomplished

Jackson (1999) and Young (2002) noted that the most common type of evaluation is a pre/post evaluation of student's achievement or students attitudes in relationship to the use of instructional techniques. However, the student outcome is concerned with ascertaining the important outcomes, intended or otherwise in the use of instructional techniques in the classroom (Bullock and Ory 2000). This implies that it may be necessary to critically examine the original objectives of a programme so that the evaluator can develop an understanding of the domain of knowledge in which changes are supposed to take place, in order to discover which mechanism are responsible for the change.

Source of data collected from competency based evaluation of learning outcomes include but not limited to the following: test scores, specific content area, reading scores, course assignment, student retention and general academic achievement (Bullock and Ory, 2000). These types of data are generally used as outcome measures as researchers on instruction techniques and learning such as shakeshaft (2000), Heinecke, Blask, Milman, Washington (2002) recommended changes in practices within the field of technology education with regard to the type of data collected. They called for a refine and expansion of student learning outcomes and a move away from gain scores to current development of cognitive psychological test. Noting that when instructional technique is integrated into the classroom academic achievement will increase. According to Ogwu and Oranu (2006) besides the general unemployment situation in Nigeria, products of technical institutions were found to posses less than satisfactory levels of employable skills. The low level of employment necessitated the United Nations Educational Scientific and Cultural Organisation (UNESCO) and National Board for Technical Education (NBTE) working jointly to revise the programme of technical institutions.

Apparently, the adjustment of the programme for these institutions will affect the curricular implementation processes. It could be deduced that the greater adjustment to be done by educational institutions could only be realized through the use of AUTOTEDRACAD being one of the modern and novel instructional techniques and could be organized as follows:

- Organize the directory such that the programme is clear, adequate and appropriate to the target users.
- Define adequately the technical terms and symbols
- Ensure the content cover the stated objectives without unnecessary redundancy and superfluous information.
- Let the programme periodically review what has been taught most recently.
- Ensure the competency based evaluation measure the user's comprehension of the content as opposed to mere recall of facts.
- Ensure the programme allows for individual differences in learning other than pacing, such as prior knowledge background, ability level, learning styles.
- Ensure that the user most actively responds to stimuli.
- Ensure that the programme require comprehension of the material rather than mere recall or coping of information.

- Ensure that the responses are in appropriate form and relevant to the objectives.
- Ensure that there are enough responses for each skill or unit of information.
- Ensure that the question requires the user to utilize the critical information rather than to recall only trivial facts.
- Ensure that the prompts make necessary response, and replace the thought processes in which the users want to engage.
- Determine questions as to allow the user to apply the information to a variety of situations.
- Ensure that the skill taught in the programme will be transferred to a real world setting.
- Determine at least one question that requires the user to respond to each important piece of information or skill.
- Ensure that the feedback is accurate, clear to the user and follow the response immediately.
- Ensure that the user sees the feedback while responding.
- Ensure that alternative answers to questions are acceptable and indicated.
- Ensure that remedial comments are provided when wrong or alternative answers are anticipated.
- Ensure that instructions allow the user to skip unnecessary repetition and to return to material when necessary.

Capabilities of Automated Technical Drawing Computer Assisted Drafting (AUTOTEDRACAD) in Teaching Technical Drawing

The utilization of AUTOTEDRACAD in teaching and learning of technical drawing could be seen as flexible, student centered and student active participant in the teaching/learning processes. The following instruction procedures are utilized in AUTOTEDRACAD classroom:

1. The objectives of each drawing are included at the top of the page of each new drawing topic. This is to enable the students to relate to previous drawings.
2. The step by step procedures for each drawing are printed on a separate sheet and titled clearly as procedures and presented to each student. These advance organizers is introduced in advance of learning itself and are presented at a higher level of abstraction, generality and inclusiveness. This enhances the strength of cognitive structure.
3. Computer directs the instruction through presentation of materials, questions and answers, and discussion of concepts.
4. Command is discussed in detail and the students who have some prior knowledge could link new ideas and concepts.
5. Introductory component of the course is allowed for students initial experimental play time. This is to allow students familiarize themselves with programme command. (e.g. toolbars, shortcuts, menu and dialog boxes).
6. Students are shown step-by-step different ways of input commands.

7. Students are asked to apply the concept of inputting command to draw lines of exact length e.g. 60mm.
8. Students are exposed to drawing interfere, programme – abilities, and could begin to associate the visual icons with the command that each one represents
9. The students have control over the pace and sequencing of the instructional information but teacher can explain certain concepts in as much detail as necessary.
10. Many entities are drawn in several ways i.e. with an icon or toolbar or by typing in different command on the command line.
11. Multiple steps to a new skill are presented at a pace that does not strain the limitation of the short term memory (STM) in students.
12. Complex tasks are broken down into manageable steps.
13. Students are presented with extensive and variable practices.
14. Ample opportunities are given to students to practice new strategies.
15. Students are paired; more knowledgeable students with those experiencing difficulty (this benefits the weaker students through timely assistance).
16. Students are encouraged to work in close proximity to each other; it gives instant feedback which may not be available on traditional method.
17. Students are given similar tasks with detailed instructions.
18. Competency based evaluation is given within the allotted class times to ensure students understand the principles, projection and can manipulate and edit sufficiently well.

19. Competency based evaluation is set at the end of the lesson.
20. Questions are judged more objectively as the computer gives immediate feedback.

Academic Achievement and Retention of Learning

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 (Olaitan, Ali, Eyo, Sowande (2000). They noted that academic achievement is always denoted by a score, which represent the amount of learning acquired, knowledge gained or skills and competencies developed in the school subject.

Artherton (2003) maintained that academic achievement is hinged on several factors including; teaching method, intelligence, background, organization, opportunity, motivation, instructional procedures, teaching aids, interest of the learner and other environmental variable. Others include learner's mental ability, his goals and purposes, his identification with learning, his maturation, and methods of guidance, availability of facilities and methods of testing.

Lowman (2006) wrote that studies have been conducted to articulate the characteristic of a good teaching and how it relates to students' academic achievement. One can be confident that the methods and tools employed by a teacher to impart the lesson could lead to students learning and academic achievement. Bar-yam et-al (2006) asserted that the effectiveness of teaching and the pertinence of the assessment of learning achievement can be enhanced by teachers' adaptation of instructional strategies to student's learning style.

Therefore, the characteristics of a good teacher lead to a successful learning achievement. One characteristic of a good teacher that is considered relevant to student achievement and retention is a sound knowledge base of the subject matter, classroom planning, management and instructional skills. Teachers must demonstrate that they posses these skills during student teaching and should be evaluated to determine if the students maintain these skills. This implies that a good teacher characteristic enhances efficient and effective students' academic achievement.

Retention could be referred to as a repeat performance by a learner of the behaviour that an acquired piece of knowledge is always intended to elicit in the learner after an interval of time. Savage and Sterny (2003) maintained that retention is the learning that last beyond the initial unit or lesson and it is assessed with test administered two or more weeks after the information have been taught and tested. This implies that a learner who repeats an acquired piece of knowledge with less error is said to have retained the material taught.

Haynie (2003) explained that retention of learning is measured with two tests; the 'initial test' and the 'delayed retention test'. In the same vein, Savage and Sterry (2003) ascertained that the initial or the pretest is the one used at the time of the instruction or immediately thereafter the delayed or posttest are those administered two or more weeks after the initial testing to measure knowledge. It could be observed that retention falls with time because several factors affect it such as the degree of the original learning, the method of measuring it and the time at which retention is measured after learning. Riding, Grimely, Dahraei and Banner (2003) identified an individual's working memory capacity and cognitive style as other factors affecting retention of learning. Realizing that memory falls and retention diminishes, Abdelhamid (2005) enlisted the following strategies to enhance retention.

- Tactical Reduction of organized Steps: This is the creation of components that aid memory by tactically reducing the information into chunk that is a little congenial to the learner's capacity.
- The Use of Analogy: This aid retention as visual images in CAD rest much more comfortably in the memory than words or numbers, analogy could be invaluable memory aids.
- Mnemonics: These are memory tricks. They are essentially gimmicks with which when put enough in the head one can recall the whole subject on demand (e.g. CAD – Computer Assisted Drafting). Abdelhamid (2005) noted that when mnemonic is creatively constructed, it could be entertaining and memory enhancing.
- Strategic Repetition: The more often one hear something the more likely to recall it. It could be strategy to incorporate some artistic repetition into one's context.

Others identified by Riding Grimely, Dahraei and Banner (2003) include:

- Practice the ability to form association between new and old concept.
- Memory Flashing: Take note and try to re-create the concepts from the memory using mind map diagrams of the materials.
- Compress the material into keyword chunks so that eventually one word will trigger off the memory of the whole paragraph.
- Verbalize, visualize and emotionalize your learning goals as if they were already accomplished. Haynie (2003); Savage and Sterny (2003) maintained that the important element of retention is comprehension because as easier the material to follow is as easier the material to recall. They asserted that a teacher who wants his or her students to remember what is taught could work hard to invest it with all the strategies for enhancing comprehension.

Gender Issues in Technology Education

Gender could be referred to as all the characteristics of males and females, which a particular society has determined and assigned each sex. According to Okoro (1993) cited in Ogwo and Oranu (2006) maintained that the male child is not just identified by his possession of certain type of genital but also by what society demands from him. Accordingly Zafrain and Zawitz (1997) noted that there are obviously biological, psychological and personal differences between boys and girls, these differences may be attributed to the upbringing and the expectation of the society. These characteristics could be said to influence every other socialization process of the male and female child. Gender schema tends to relate most of the vocational trades to the masculine gender. Differential performance of the sexes in technology education as noted by Haynie (2003) has shifted as a result of shift in curriculum from the industrial shops of the past toward computers, communication, bio-medical technology, design, graphics, research and development and similar topics were mentioned as a positive change in making the field of technology attractive to girls.

Traditionally, technology traits are believed to include remoteness, impersonality, detachment and objectivity (Birke 1996). More often than not, these traits are readily associated with the male in society, while passivity, nurturance and subjectivity are held to be feminine attributes with this association, science and technology seems to be given to masculine gender. He noted that this attribute and other social psychological barriers alienate girls with potentials. Females often make choices that exclude them from science and technology. Similarly, the United National Conference for women emancipation recommended that the remaining barrier of higher education should be removed and the education of girls in science and technology encouraged.

In the same vein Haynie (2003) identified things that technology education should do to attract female into the profession as follows:

- Increase in girl's involvement in Technology Student Association Conference.
- More female role as model teachers.
- Shift in general society, which shows women in more assertive and non-stereotypical roles in television.

- Equity camps, technology camps with high visibility events such as standard research efforts and affirmative action efforts designed to attract more girls.

Meanwhile literature according to Zafrain and Zawitz (1997); Erinosho (2004) have stated that girls out-perform boys in verbal skills, conventional wisdom would have the boys outperforming girls in mathematics, they noted that girls lack somewhat in mathematics problem solving but are slightly more proficient in skill. Erinosho (2004) agreed that boys are better than girls at spatial tasks and large motor skills such as mathematical reasoning while girls do better on precision or perceptual and fine motor skills such as verbal fluency. Kumari (1999) however, maintained that there is no difference in vocabulary and reasoning between boys and girls and those girls are better at retention than boys. These findings were attributed to gender differences in the brain which influences human strength and weaknesses through life and the performance of different cognitive tasks.

Girls approach technology differently, Hamacheck (2001) highlighted that to some extent because of the parental background or influence, all educational system including technology education are said to influence the gender gap. Girls may likely be involved in more social games while teachers may treat boys differently than girls causing different expectations. As a result of this treatment, girls often refrain from asking question and sharing answers, and intelligence. Sometimes feel inferior to others and wish to mask their leadership abilities. Lack of female role models is believed to be another reason for the gender gap in technology education. Haynie (1999) asserted that providing students the opportunity to see guest speakers from both genders in non-traditional career develop communication with other females who have careers in science and technology field, would likely cause the students to have high expectations for themselves.

These girls will perceive science and technology fields as plausible careers for themselves. It could be observed that parents' actions toward both sexes could inevitably influence the children; this implies that parents should closely examine what they say to their children. Children should be exposed to technology at any early stage. Discussing technology with girls is another way parents could encourage their female children into technology education (Erinosho, 2004). He maintained that as teachers praise girls for their appearance and cleanliness they should also be encouraged and praised for their abilities skills, creativity and ideas, as these could strengthen and develop them in technology education. Administrators should put scholarship policies in place that ensures exposure of girls to technology education. It is pertinent that teachers be aware of the innovations in classroom management plans and teaching strategies, which are fair and equitable to all students. This implies that teachers need to pay careful attention to the gaps between students of different characteristics to make sure the assumptions of their own cultural background do not inadvertently hamper any child's success.

The Need for Change of Methodology

The 21st century is witnessing a series of transformation that are broad, and closely interrelated. This transformation could be seen to be synonymous to the invention, expansion and innovative that boarders around new information and communication technology. This undoubtedly has created numerous risks for education world over as Hallak and Poisson (2000) ascertained that this out model methodologies in education require a change in a complex society as in Nigeria. There has been a growing awareness for the necessity to change and improve the preparation of students for productive functioning in the continually changing and highly demanding environment.

> *Indeed, any strategy for change in methodology must contend with the diverse factors affecting the education system, the interaction of its parts and the intricate interdependence within its environment*. (Bar-Yam et-al 2006),

They noted that a key insight from complex systems is that simple solutions are not likely to be effective in the case of education system. In consideration of a solution Bar-Yam and others (2006) noted that for an improved methodology in technology education the following must be obtained:

- There should be integration of common polarized goals of education that is goal that focuses on transmitting knowledge with the goal that emphasizes the development of the individual students.
- Adapting teaching to different student characteristics by using diverse methods of teaching.
- Adaptation to the ability levels, patterns of different abilities, learning styles, personality characteristics and cultural backgrounds.

- Integrating the curriculum by developing interdisciplinary curriculum units that enable students to acquire knowledge from different disciplines.

The approaches to teaching and learning can be categorized according to major educational goals that affect teaching strategies. On one hand, Brooks and Kopp (2003) viewed goal of education as the transmission of knowledge by teachers to the students. On the other hand, Vygotsky (1978), Mayer (2003) viewed goal of education as facilitating student's autonomous learning and self-expression.

The former approach which converges toward the teaching of specified subject matter may be termed convergent teaching and the latter approach which stresses open ended, self-directed learning may be termed divergent teaching. The convergent approach according to Ernest (2003) is highly structured and teacher-centered, the students are passive recipient of knowledge transmitted to them and learning achievements are measured by standardized or teacher pen and paper test. The divergent approach according to Bar-yam, Rhoades and Sweeney (2006) is flexible, student-centered, where the students are active participant in the learning process and learning achievement are measured or assessed by a variety of evaluation tools such as self-evaluation in parallel to teacher evaluation.

In the highly complex education system there could be various combinations of the different approaches to tackle methodology as educators seek ways to meet the demands put upon the education system in today's world of rapid changes and ever increasingly complexity. However, Bruning

(2003) maintained that there is need to recognize both convergent and divergent approaches to teaching and learning e.g. divergent approach is needful for acquisition of specific knowledge while convergent is needful for academic skills such as reading, writing, calculating and so on. Since the creative process involves opportunities for students to acquire such knowledge, such language which can be acquired by convergent teaching, Shavininas and Loarer (2002) asserted that convergent and divergent teaching strategies are both needed and the challenging question is how to find the balance between them within the complexity of the process of teaching and learning. This implies that the two approaches may increasingly become not mutually exclusive but interrelated and interdependent.

However, United Nation Educational Scientific and Cultural Organization UNESCO with ILO (2002) agreed that following the immense scientific technological and socio-economic development as envisaged within the present era, particular attention should be given to globalization and communication technology such that Technical and Vocational Education (TVE) system should be geared toward lifelong learning. This implies that TVE system worldwide need to develop the knowledge and skills that could help the workforce in the profession to become more flexible and responsive to the needs of local labour markets, while competing in the global economy.

Globalization according to Thakur (2006) is a mark of paradigm shift in economic thinking on the part of economic philosophers and policy makers and represents an on-going process of change and adaptation. One often hears “the world has now become a global village” thanks to narrowing down the geographical distances and of barrier in thinking patterns between developed and developing countries. Globalization from the technical perspective is the fast and significant technological process in the communication field, which has permitted users to have access and exchange information at anytime and from any place in the world. However, Hallak and Poisson (2000) noted that it led to the emergence of more learning societies due to the multiplication of sources of information and communication. It is essential to understand such technological transformations and define the action needed to support appropriate methodology in order to respond to the new situation and develop more diverse activity within the profession.

Seng and Heng (2002) contended that the traditional approach of delivering knowledge and skills must be looked into in favour of methodologies which allow students to learn needed skills in the context within which the skills are used in the real world. Bar-Yam et-al (2006) called this method multi-convergent; this approach they noted can be more effective in giving the students opportunities to use their aptitudes and inclination for learning and attaining higher achievement. This new methodology entails that as the students experience success and consequently a sense of competence, their motivation is enhanced to pursue further learning. Such an approach has a better potential for success than the common reality of students with learning difficulties who often struggle through remediation with a sense of inadequacy and discouraging experiences of failure. This implies that each student should be allowed to work at his or her own pace as there are many possibilities of adaptation through the use of diverse method of teaching.

Teachers could use different methods, different techniques or different media to cater for individual differences in abilities and personality characteristics even when all the students are taught the same material. Meanwhile, Owston (2004) asserted that there seems strong need to train teachers to adapt instruction to the diverse students' abilities, learning styles, personality traits and needs by using more differentiated teaching strategies. He noted that with the provision of high-tech resources such as multimedia technology, computer programme, telecommunication, the internet, audio-visual techniques and others, these could be a beneficial option to meet student's varying needs and styles. At this juncture Owston advocated that there is need to design instructional strategies and learning materials to provide options and flexibility for matching students' particular patterns and abilities.

Review of Related Empirical Studies

Vrinten (2002) in his study to improve learning in Computer Assisted Drafting Programme used 30 students who had no prior knowledge of Computer Assisted Drafting. Through the use of students' workbook developed for the course, the students work to complete the course objectives within the allotted 25 hours of class time. The study revealed that the implementation of CAD improve students' learning in the following ways – enhance organizational strength of cognitive structure, increase students' motivation, curiosity and interest.

In a research study conducted by Mackenzie and Jansen (2002) they were interested to know the impact of multimedia computer-based instruction on student comprehension of drafting principles, came up with the study on both quantitative and qualitative research methods. They drew their sample for the study from students of technical graphic (design/drafting) Montana State University/Northern Colorando State with population of 137 students. They identified that multimedia based approach was significantly more effective than the traditional format in academic achievement and in retention of the instructional information during the treatment period as well as capturing and maintaining student attention.

Similarly, Collins and Brown (1991) conducted a study on the effects of Computer Assisted Drafting on information density on medical student's achievement. The lectures were presented to a total of 23 student randomly distributed into three groups. They were concerned about the explosion of information available in medical texts and the perceived need by lecturers that they must cover even more materials in the limited time available. Statistically, the result revealed that limited amount of new information can be learnt in a given time. Teachers should only present basic materials necessary to achieve objectives in a step-by-step form as perceived by the constructivist researchers.

In another research study to find out the effects of performance and attitudes towards instruction of learners working individually on a computer-based sex education lesson, Dalton, Hannafin, Hopper (2003) compared with those learners working cooperatively in dyads. A total of 60 eight-grades received treatment that either required individual work or encouraged cooperation with partner. Results indicated that students who worked cooperatively significantly outperformed those who work individually on an attitude measure; interactions were detected between instructional method and gender, as well as among instructional method, gender and ability. High ability males and females reported comparable attitudes toward each instructional method, but rating for low-ability students were differentiated according to instructional method. Ability males responded most favourably while low-ability females responded least favourably to individual methods, low-ability females responded most favourably and low ability males least favourably to cooperative methods.

Similarly, in a study conducted by Amuludun, Lemo and Usoro (2006) on the effects of multidimensional learning model on students' Academic Retention and Achievement in Technical Drawing. The study's Sample was of the *"convenience"* type. The result among others indicated that multidimensional learning model is significantly more effective than the traditional format in students' academic retention and achievement. For retention to be enhanced in students technical teachers should give attention to memory strategies to ensure that short term memory is not overloaded.

In a study conducted by Roth, Woszcyna, and Smith (1996) to investigate how computer and modeling software contributed to students' interaction and learning in a physics course. They use a student population of 162 randomly sampled, their result and interpretation shows that although the computer micro world contributed in significant way to the maintenance and co-ordination of student's physics conversation, yet the computer environment was sometimes unready to hand so that students spent more time hearing the software rather than physics and also limited the interaction within groups.

Haynie (1999) in his study on gender issues in technology education, investigated on 27 young women on how professionals in technology education feel about certain issues concerning cross-gender interaction. Haynie had the following findings that:-

(1) Technology education is still somewhat a male dominated field.

(2) Several young women mentioned that they were better accepted by younger men who had joined the profession.

(3) Breaking down of sex role stereotypes within societies at large is helping in technology education.

It was therefore recommended that more women should be encouraged to enter the profession and advance to position of leadership in which they may serve as role models.

In a similar study conducted by Osuagwu (1990) to find out the learning and retention effects of using pictorial and real objects in teaching technical drawing. The study revealed among other things, that students taught technical drawing using pictorial and real objects as models performed significantly better ($p < 0.05$) than a comparable group of students taught using conventional teaching method. Also in a study evaluating the effectiveness of the use of models, simulation and games in teaching a concept in geography on students' academic performance, Anikweze (1988) found that the students taught with the use of models, simulations and games performed significantly better than the comparable students taught with the conventional methods.

Summary of Literature Review

The various literature reviewed so far revealed that Computer Assisted Drafting came into education some decades ago and has added tremendous dimension to teaching and learning by emphasizing multiplicity of instruction techniques in order to address students' diverse dispositions and learning. The review has also shown that computer assisted drafting has been widely accepted as a better instructional method in this age of Information and Communication Technology (ICT), following the short coming of the traditional methods of teaching and learning. It seems that even though there has been other instructional techniques that could be adapted to address and enhance students' various capabilities, computer assisted drafting can present multiple, dynamically link representation in ways that are impossible with static, inert media such as books and chalkboard.

The review highlighted the characteristics of a teacher with the conventional approach to technical education. It noted that technical education is founded upon both implicit and explicit theoretical frameworks. These frameworks allow scholars to organize and synthesize knowledge and conjecture within a field and serve to describe, explain and predict behaviour and experiences. Moreover, technical drawing is meant to be a trade related subject offered in technical colleges to develop students' technological and creative capabilities with relevant knowledge and skills in designing, drafting communication, construction and modeling. The review revealed that up till now computer assisted drafting instruction has not been implemented with technical drawing in technical colleges.

The review revealed that academic achievement and retention of learners could be enhanced when teachers adapt instruction strategies to students' learning style. It has also been found that there are changes in the workplaces as a result of the effects of globalization and the rapid revolution in information and communication technology. These changes are needful for a re-alignment of curriculum content and instruction techniques with current realities if technical education graduates are to survive in the continuously changing and complex society.

The review revealed that there is no empirical study done on the effects of Automated Technical Drawing Computer Assisted Drafting AUTOTEDRACAD techniques on students' academic achievement and retention in technical drawing. However, the studies done in physics, engineering graphics, architectural designs and medical education have shown that computer assisted drafting instruction techniques improve students' academic achievement, retention, learning rate, attitudes and interest in those subject areas.

This study therefore intends to bridge the gap by determining the effects of Automated Technical Drawing Computer Assisted Drafting (AUTOTEDRACAD) technique on students' academic achievement and retention in technical drawing, and by equipping student with not just skills needed for today but for lifelong academic/work place skills needed for today’s new technologies and challenges which come at increasing speed.

CHAPTER 3

METHODOLOGY

This chapter presents a description of the method adopted for the study under the following subheadings: the design of the study, area of the study, population of the study, sample for the study, instrument for data collection, validation of instrument, reliability of instrument, method of data collection, experimental conditions, experimental procedure and method of data analysis.

Design of the Study

The study used the quasi-experimental pretest posttest design. The design was adopted as it was not possible for the researcher to randomly sample the subjects and assign them to groups without disrupting academic programmes of the college involve in the study.

Design is represented below

Experimental group O_1 x O_2

Control group O_3 – O_4

O_1 and O_3 represents the initial observation (pretest)

O_2 and O_4 represents the final observation (posttest)

X represents the treatment

\- represents no treatment

Area of the Study

The study was conducted in Akwa Ibom State in the five private and six public own technical colleges that use computer. The choice of Akwa Ibom State was informed by the fact that Information and Communication Technology has received a wider acceptance both in the Akwa Ibom State ministries and in the private sector. Moreover, the State Technical Schools Board has provided the technical colleges with well equipped workshops, classrooms, drawing studio, equipment and technical education personnel needed for carrying out the research.

Population for the Study

Data obtained from the statistics department of Akwa Ibom State technical schools board/NBTE, Akwa Ibom State branch showed that there are six government technical colleges and five private own technical colleges and has a total of 2110 year-two technical students in 2006/2007 school year.

Technical drawing being a trade-related subject is compulsory for all students in both engineering trades and construction trades. Invariably it means that the same number of students offered technical drawing, hence the population of the study is 2110 students as shown in the (Appendix A).

The future studies should separate the personality of the technique originator from the technique itself to prove its generalizabilty. This could be achieved using the model in a CAI form e.g. drawing slides, pictures, animation, and other multimedia potentials. This technique many prove to be useful supplement for problem learning.

Sample for the Study

Simple Random Sampling Technique was used to select the sample for this study. Two state technical colleges were randomly sampled from the five private own technical colleges and two from the six public own technical colleges. Lastly, two arms of year two technical students representing Engineering and Construction trades were purposively sampled from the four technical colleges to ensure experimental and control group treatment. From the available statistics, each class of technical year-two student contains an average of 30 students; hence the sample size of this study was 240. (Appendix B)

Instrument for Data Collection

The instrument for data collection in this study was Technical Drawing Achievement Test (TDAT) constructed by the researcher. The Technical Drawing Achievement Test (TDAT) consisted of 48 multiple choice items, and two hands on activity items. These questions were used for the pretest, later it was restructured for both the posttest and retention test (Appendix E).

Instrument for treatment of Experimental and Control groups:

The Automated Technical Drawing Computer Assisted Drafting lesson plan developed by the researcher (Appendix G) and Conventional Lesson Plans (Appendix F) constituted the instruments for treatment of the experimental and control groups. Each AUTOTEDARCAD lesson plan incorporated at least four AUTOTEDRACAD techniques in one. These are:

sequential instruction, multi-sensory presentation, surface modeling, problem solving and competency based evaluation techniques.

The techniques found in AUTOTEDRACAD were not taught in isolation but they were interwoven in the lesson and more than one AUTOTEDRACAD technique addressed in a single step of instruction. Each AUTOTEDRACAD lesson plan indicated among others, the lesson topic, specific objectives, entry behaviour, instructional materials and the instructional procedure. The instructional procedure showed details of the steps, content development, student's activity, AUTOTEDRACAD techniques, remedial, level of attainment and skills acquired.

Validation of Instrument

Technical drawing achievement test was face and content validated by five experts two from the department of vocational teacher education, one from Science Education, and one computer expert all in the University of Nigeria, Nsukka and one Technical Drawing expert from the department of technical education University of Uyo. These experts reviewed the instruments and their corrections were incorporated in the final copy of the instrument.

Reliability of the Instrument

The reliability coefficient was determined using Pearson's product moment correlation statistical tool after test–retest method. This reliability technique is appropriate for this study as it involves repeated measurement with the same instrument (Ezeh 2005). The Technical Drawing Achievement Test recorded a reliability coefficient of .78

Method of Data Collection

The researcher with the aid of regular subject teachers subjected the eight purposively sampled intact groups to pre-testing exercise with the Technical Drawing Achievement Test, to test the intelligence status. Thereafter, the experimental group was subjected to the treatment after which the posttest was administered to both groups.

The scores of the experimental group in both pretest and posttest were recorded and compared with the scores obtained by the control group in both test. Two weeks later, the same posttest was administered again on both groups to assess the extent of retention of the material learnt by the students. The scores was recorded and compared.

Experimental Conditions for the Control of Extraneous Variables

(i) Experimental Bias: To avoid any experimental bias, the researcher was not directly involved in the administration of the test; rather the regular subject teachers in the participating colleges taught their own students in both experimental and control groups.

(ii) Teacher Variability: To control the invalidity and ensure a uniform standard in the conduct of the research, the researcher personally prepared Automated Technical Drawing Computer Assisted Drafting lesson plans/software, Technical Drawing Achievement Test (TDAT) and the Conventional Lesson Plan. The participating teachers received intensive training for two weeks but did not have access to the test instrument until it was time for administration. The same lesson content was taught to both groups, as the students in both groups were not informed of their involvement in the research process. This is to enable them be natural and prevent them from acting in any manner that could influence the result of the research negatively or positively.

(iii) Training of Teachers: A two weeks intensive training programme was organized for the participating technical teachers. AUTOTEDRACAD software was loaded onto individual computer as an interactive tutorial / learning system. Technical Teachers in the experimental group were given detailed explanation on the use of AUTOTEDRACAD technique, AUTOTEDRACAD lesson plans and how to incorporate the AUTOTEDRACAD techniques into the lesson and the general requirement of the research. Technical Teachers for the control group were briefed on the general requirements. They were only required to use the conventional lesson plan to teach. At the end of the training, the researcher organized a micro teaching session for the participating teachers to ensure their mastery of the instructional techniques.

Experimental Procedure

The experimental group was taught ten AUTOTEDRACAD lesson plans developed into software, while the control group was also taught ten Conventional Lesson Plans, using demonstration method. Each lesson lasted for a double period of 45 minutes with $^{1}/_{3}$ of the time devoted for lecture while the remaining time was devoted to practical activities. The control group used manual drawing instruments, chalkboard, still pictures and physical models to assist in the presentation of the materials.

The lesson was taught for two times a week and the treatment lasted for 5 weeks. The class was structured to cover the fundamental principles and practice of technical drawing as stipulated in the National Board for Technical Education Curriculum 2001 (NBTE). The application of drawing in the manufacturing and construction industries, alphabets, lines and lettering, simple geometrical construction, basic principles of orthographic projection, principles of dimensioning, sectioning, and auxiliary plans and elevations and principle of loci, identical materials were covered in both sections.

Since three weeks period was left within the two months of treatment, posttest was administered on both groups with TDAT and scores obtained from both groups were compared to determine if there was any significant difference in the performance of the two groups. After 2 weeks later, a posttest was given to both groups and the scores compared to determine if there was significant difference in the extent of retention of the learning by the two groups.

Methods of Data Analysis

The research questions were answered using mean and standard deviation of the test scores, while analysis of covariance (ANCOVA) was used to test the entire null hypothesis at 0.05 level of significance. This is because ANCOVA is a statistical technique, which removes the initial differences between groups, such that the pre-tested groups can be correctly considered as equivalent by removing scores difference in the pretest performance across groups and reducing the in-between group sources in variation. In view of the above therefore, ANCOVA was considered appropriate for the present study.

CHAPTER 4

PRESENTATION AND ANALYSIS OF DATA

This chapter deals with the presentation and analysis of data collected for the study. Using appropriate statistical tools, relevant interpretations were made based on the research questions and hypotheses that guided the study.

Research Question 1

What are the effects of AUTOTEDRACAD technique on students' academic achievement in technical drawing? Data for answering the above question were presented in Table 1.

Table 1

Mean and Standard Deviation of Pretest and Post Test Scores of Experimental and Control Group using AUTOTEDRACAD Technique

Group	N	Pretest		Post Test	
		$\overline{X}$	SD	$\overline{X}$	SD
Experimental	120	29.11	7.68	50.30	13.68
Control	120	30.45	7.64	48.77	14.53
Total	**240**				

The data in Table 1 revealed that the experimental group had a mean of 29.11 and a standard deviation of 7.68 in the pretest, and a mean score of 50.30 and a standard deviation of 13.68 in the post test making a pretest – post test gain of 20.19. The control group had a mean score of 30.45 and a standard deviation of 7.64 in the pretest and a mean score of 48.77 and a standard deviation of 14.53 in the post test with a pretest gain of 18.32. The result showed that the experimental group performed better than the control group with the pretest-posttest gain of 2.88.

Research Question 2

What are the Comparative Technical Drawing Achievement Test (TDAT) scores of students' (girls and boys) taught with AUTOTEDRACAD Technique? Data for analyzing the above question were presented in Table 2.

Table 2

Mean and Standard Deviation of Achievement Scores of Girls and Boys taught with AUTOTEDRACAD Technique

Group	N	Pretest		Post Test	
		$\overline{X}$	SD	$\overline{X}$	SD
Boys	102	30.05	7.72	49.16	14.36
Girls	18	32.72	6.93	46.55	15.69
Total	**120**				

The data on table 2 showed that male students had a mean score of 30.05 and a standard deviation of 7.72 in the pretest and a mean score of 49.16 and a standard deviation of 14.36 in the post test score making a pretest – post test gain of 19.11 while the female students had in the pretest 32.72 as mean score and 6.93 as standard deviation, while in post test 46.55 as mean score and 15.69 as standard deviation. This leaves the female students with pretest gain of 13.83. The difference of 5.28 in the male's gains indicated that boys performed better than girls.

Research Question 3

What are the effects of AUTOTEDRACAD Technique on students' (girls and boys) retention in technical drawing? Data for answering this question is presented in Table 3.

Table 3

Mean and Standard Deviation on AUTOTEDRACAD Technique on Girls and Boys Retention in Technical Drawing

Group	N	Pretest		Post Test	
		$\overline{X}$	SD	$\overline{X}$	SD
Boys	102	49.16	14.36	50.86	15.72
Girls	18	46.55	15.69	51.88	17.13
Total	**120**				

The data presented on Table 3 indicated that boys had a mean score of 49.16 and a standard deviation of 14.36 in the post test, and a mean score of 50.86 and standard deviation of 15.72 in the retention test. The girls on the other hand, had a mean score of 46.55 and a standard deviation of 15.69 in post test, and a mean score of 51.88 and a standard deviation of 17.13 in the retention test. This means that though boys performed better than girls in pretest, girls in the other hand, retained better than boys with a mean gain of 3.36.

Research Question 4

What are the effects of AUTOTEDRACAD technique on students' retention in studying technical drawing? Data for answering the research question were presented in Table 4.

Table 4

Mean and Standard Deviation of Students' Retention Scores, Experimental and Control Group when taught with AUTOTEDRACAD Technique

Group	N	Pretest		Post Test	
		$\overline{X}$	SD	$\overline{X}$	SD
Experimental	120	50.30	13.68	52.42	15.09
Control	120	48.77	14.53	51.01	15.87
Total	240				

From the data presented on Table 4, the experimental group had a mean score of 50.30 and a standard deviation of 13.68 in the post test and a mean score of 52.42 and a standard deviation of 15.09 in the retention test. The control group had a mean score of 48.77 and standard deviation of 14.53 in the post test and a mean score of 51.01 and standard deviation of 15.87 in the retention test. The experimental group gain of 1.41 in retention test indicated that experimental group retained better than control group.

Hypothesis 1

There is no significant mean difference in the achievement scores students' taught using AUTOTEDRACAD technique and students' taught using demonstration method in technical drawing.

Table 5

Analysis of Covariance on Students' (Experimental and Control) on Academic Achievement of Students Using AUTOTEDRACAD Technique and Demonstration method in Technical Drawing

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	35128.433a	2	17564.217	334.806	.000
Intercept	37887.449	1	37887.449	722.204	.000
Pretest	62.596	1	62.596	1.193	.276
Groups	34072.253	1	34072.253	649.479	000
Total	636513.000	240			
Corrected Total	47561.663	239			

$P<0.05$

Decision: The result on Table 5 showed that calculated F. ratio for the group treatment on the students' academic achievement in AUTOTEDRACAD technique is 649.479 with .000 level of significance thus, the null hypothesis of no significant difference between mean achievement score of student's taught using AUTOTEDRACAD technique and demonstration method in technical drawing was rejected at 0.05 level of significance. This means that the f-cal was statistically significantly at $p<0.05$ level. Thus, indicating that

AUTOTEDRACAD technique was significantly more effective than the demonstration method.

Hypothesis 2

There is no significant mean difference in the achievement scores of students' from engineering trades and construction trades when taught with AUTOTEDRACAD technique.

Table 6

Analysis of Covariance on Mean Score of Students from Engineering and Construction Trades when taught with AUTOTEDRCD technique

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1272.700	2	636.350	3.258	.040
Intercept	24923.144	1	24923.144	127.607	.000
Pretest	1133.163	1	1133.163	5.802	.017
Trades	216.520	1	216.520	1.109	.293
Error	436513.000	237	195.312		
Total	636513.000	240			
Corrected Total	47561.663	239			

$P < 0.05$

Decision: In Table 6, no significant difference was detected between the two trades group (engineering and construction trade) for the treatment as their achievement score was 1.109 at .293 level of significance. This means that f-cal is not statistically significantly at $p<0.05$ level because .293 greater than 0.05 level. Thus, null hypothesis of no significant difference between engineering and construction trade was accepted at 0.05 level of significance and the null hypothesis was retained.

Hypothesis 3

There is no significant mean difference in the achievement scores of students' (boys and girls) when taught with AUTOTEDRACAD technique.

Table 7

Analysis of Covariance on Mean Achievement Scores of Boys and Girls taught with AUTOTEDRACAD technique

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1334.745	2	667.372	3.422	.034
Intercept	21114.285	1	2114.285	108.250	.000
Pretest	1150.762	1	1150.762	5.900	0.16
Sex	278.565	1	278.565	1.428	.233
Error	46226.918	237	195.050		
Total	636513.000	240			
Corrected Total	47561.663	239			

$P < 0.05$

Decision: The above Table 7 has shown that the calculated F-ratio for sex treatment with AUTOTEDRACAD technique was 1.428 with a significant difference of .233. This implies that at 0.05 level of significance, f-cal is not statistically significant. Thus, there was no observed significant difference in the mean achievement score of boys and girls taught with AUTOTEDRACAD technique. Hence the null hypothesis was retained.

Hypothesis 4

There is no significant interaction effect of AUTOTEDRACAD technique and area of specialization on students' achievement scores in technical drawing.

Table 8

ANCOVA Table for Testing the Interaction Effect of Technique and Area of Specialization

Source	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	35252.791	2	8813.198	168.261	.000
Intercept	34964.887	1	34964.887	667.547	.000
Pretest	43.413	1	43.412	.829	.364
Trades	124.358	1	124.358	2.374	.125
Groups	33867.390	1	33867.390	646.594	.000
Trades and Groups	.076		.076	.001	.970
Error	12308.871	235	52.376		
Total	636513.000	240			
Corrected Total	47561.663	239			

$p < 0.05$

Decision: The F-ratio calculated in Table 8 on the trade group interaction treatment on technique and areas of specialization on students' achievement was .001 with .970 level of significance. The f-cal is not statistically significant at 0.05 level. Thus, the null hypothesis of no interaction effect between groups (Engineering/Construction Trade) was accepted at 0.05 level of significance. Hence the null hypothesis was retained.

Hypothesis 5

There is no significance mean difference in AUTOTEDRACAD technique and Demonstration method on students' retention in studying technical drawing.

Table 9

Analysis of Covariance on the Mean Retention between students taught with AUTOTEDRCAD and Demonstration method.

Source	Sum of Squares	df	Mean Square	F	Sig
Corrected model	47788.223	4	11947.056	303.673	.000
Intercept	14105.107	1	14105.107	358.527	.000
Posttest	12.297	1	12.297	.313	.577
Groups	11005.492	1	11005.492	279.740	.000
Error	9205.994	234	39.342		
Total	696301.000	239			
Corrected Total	56994.218	238			

$P < 0.05$

Decision: The above table 9 on the mean scores of students' retention in technical drawing when taught with AUTOTEDRACAD technique and those taught with demonstration method was 279.740 with .000 level of significance. Thus the f-cal is statistically significant at 0.05 level. Hence the null hypothesis was rejected at 0.05 level of significance. This implies that students receiving AUTOTEDRACAD technique had retained technical drawing information at significantly higher level.

Hypothesis 6

There is no significance mean difference in AUTOTEDRACAD technique on students' (boys and girls) retention in studying technical drawing.

Table 10

Analysis of Covariance on AUTOTEDRACAD Technique on Retention of Boys and Girls in Technical Drawing

Source	Sum of Squares	df	Mean Square	F	Sig
Corrected model	47788.223	4	11947.056	303.673	.000
Intercept	14105.107	1	14105.107	358.527	.000
Posttest	12.297	1	12.297	.313	.577
Sex	.010	1	.010	.000	.988
Error	9205.994	234	39.342		
Total	696301.000	239			
Corrected Total	56994.218	238			

$p<0.05$

Decision: The above Table 10 on the mean scores of boys and girls retention on AUTOTEDRACAD technique showed that the f-cal of .000 with .988 level of significance was recorded. Thus, f-cal is not statistically significant at 0.05 level, thus indicating that there was no significant difference between boys and girls. Hence, the null hypothesis was upheld at 0.05 level of significance.

Findings of the Study

On the basis of the data collected and analyzed for the study, the following major findings were made with respect to the research questions and hypotheses.

1. Students taught with AUTOTEDRACAD technique scored higher in the post-test than those taught with conventional demonstration method. This means that AUTOTEDRACAD technique of Sequential Instruction, Multi Sensory Presentation, Surface Modeling, Problem Solving and Competency Based Evaluation is more effective in enhancing academic achievement in technical drawing than the demonstration method.
2. Boys taught with AUTOTEDRACAD technique had a higher score in the post-test than girls taught with the same AUTOTEDRACAD technique. This could explain the fact that boys are naturally interested and better in technical subjects than girls.
3. Though boys taught with AUTOTEDRACAD Technique performed better than girl in post-test, Girls taught with AUTOTEDRACAD Technique on the other hand retained better than Boys in Technical Drawing
4. Students taught with AUTOTEDRACAD technique had a higher mean score than those taught by the Demonstration method in Retention test. This implies that AUTOTEDRACAD technique of sequential instruction, multi-sensory presentation, surface modeling, problem solving and Competency Based Evaluation is more effective in enhancing students' retention of learning in technical drawing than the demonstration method.

5. There was a significant mean difference in the scores of students taught with AUTOTEDRACAD technique and those taught with the demonstration method in achievement test
6. There was no significant mean difference in the scores of boys and girls taught with AUTOTEDRACAD technique.
7. There was no significant mean difference in the scores of students engineering and construction trades taught with AUTOTEDRACAD technique.
8. There was no significant interaction effect of AUTOTEDRACAD technique and area of specialization on students' achievement score in technical drawing.
9. Students taught with AUTOTEDRACAD technique retained information at a significant level than those taught with demonstration method.
10. There was no significant mean difference in the score of boys and girls in retention test taught with AUTOTEDRACAD technique.

Discussion of Findings

The analysis of the result of the achievement test shown on Table 1 indicated that experimental group had higher mean scores than the control group in post test. 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, the analysis of covariance of the post tests scores presented on Table 5 confirmed that the differences between the mean scores of students in both groups in the post test is significant. This significant difference is attributed to the treatment. These findings showed that AUTOTEDRACAD technique has proved to be more effective in facilitating the acquisition of academic achievement in technical drawing. This implies that the attributes of AUTOTEDRACAD technique involves a broad spectrum of structures such as Sequential Instruction, Multi-Sensory Presentation, Surface Modeling, Problem Solving and Competency Based Evaluation. This technique is more effective than the demonstration method in enhancing academic achievement.

These findings that AUTOTEDRACAD technique hold positive effect on students' academic achievement is in consonance with the works of Mackenzie and Jansen (2002) who noted that impact of multi-media computer based instruction on students comprehension on drafting principles was significantly more effective than the traditional format in academic achievement and retention. Similarly, the work of Mclnerney and Mclnerney (1994) agreed with the present study that basic material in a step by step format as perceived by the constructivist researcher enhances academic achievement.

These findings explained the fact that certain instructional technique influences certain cognitive processes and for teaching to be effective and learning to occur the teaching/learning environment must be tailored to a real world situation which could be created in less time and faster efficiency knowing that technical drawing is hinged upon the use of graphic language of communication. This in turn explained the fact that it is anomaly to continue using absolute manual and limited drawing instrument, whereas there is availability of AUTOTEDRACAD technique which allows learners to construct their own model of the environment and obtained immediate result.

In a corresponding study by Vrinten (2002), Kulik and kulik (2003) they summed it up that's instruction technique found in Computer Aided Instruction (CAI) offer to the learner consistency of training to many sets of students in terms of quality, consistent of information presented as shown in tutorial discourse along with procedure. To add to that, Seng and Heng (2002), noted that an approach in Computer Assisted Drafting (CAD) has far better potentials, captivating and maintaining attention for success. This implies that AUTOTEDRACAD allows student to experience success and consequently a sense of competency, as a result of prompt feedback motivation is enhanced to pursue further learning. It is a well known fact that problem solving is a basic skill in life and essential to the understanding of courses in technical education. Thus, Problem Solving in AUTOTEDRACAD increases student's ability to explore issues and articulate their own ideas, solving problems, thinking critically, and reasoning out solutions

The analysis of covariance between the mean of boys and girls taught with AUTOTEDRACAD technique in achievement test on Table 7 showed that the null hypothesis was retained. This means that there is no significant difference between the mean score of boys and girls in the experimental group in Technical Drawing Achievement Test (TDAT). Although the mean score of boys in the pretest and post test presented on Table 2 was found to be slightly higher than those of the girls these could be explained by the fact that boys are naturally better in technical subject than girls, but the difference was not high enough to be deemed significant. Thus, any observed difference in their scores could be attributed to sampling error. The finding that there is no significant difference in TDAT achievement test when taught with

AUTOTEDRACAD is in consonance with the findings of Haynie (1999) that Gender Schema tends to relate most of the technology trades to masculine gender but with the shift in curriculum from industrial shop toward computer communication and graphic design, there is no significant difference in academic achievement of boys and girls. The result also supports the works of Ogwo (1996) who reported that male and female students have no difference in cognitive achievement in metal work. The result of Adey, Robetson and Venville (2002) also found that boys and girls made the same gains in post test scores in an achievement test.

The result confirmed what Kumari (1998) ascertained that boys are better than girls at spatial and large motor skills while girls do better in precision or perceptual and fine motor skills. The slight superiority in the post test could also be attributed to the fact that teacher may treat boys differently than girls causing different expectation. The analysis of the result of the retention test between boys and girls taught with AUTOTEDRACAD presented on Table 3 showed that girls had a higher mean score than boys in post test though there was a higher mean score of boys over girls in the pretest, this could be attributed to the initial differences between the subject in both groups, the analysis of covariance in Table 10 showed that there was no significant difference observed between the mean score of boys and girls in retention test. The finding that there is no significant difference in retention test of boys and girls is in consonance with the work of Bangert-Drowns, Kulik and Kulik (2006) who supported the present findings that the effect differences was found in favour of girls over boys in meta-analysis but the differences fall short of statistical significance. Furthermore, the result confirmed the works of Kumari (1998). Momoh-olle (1997) and Riding et- al (2003) that retention of learners is not affected by gender but by the degree of the original learning, the time retention is measured and the individual working memory capacity among others. Thus, since boys and girls were taught the same thing, the acquired the same degree of original learning, hence, their retention of learning was not significantly different. This result is however, contradicted with the result of Haynie (2003) who found that there was a significant difference between boys and girls in metal technology in favour of the boys. In the same vein, the result of Igboko (2004) contradicted the present result, who noticed that there was significant difference in retention in introductory technology between boys and girls who were taught by the constructivist method in favour of boys.

This implies that several young women were better in academic achievement and in retention. Thus, breaking down the sex role stereotype within the school and society could help technical education by fast academic potential of women.

The analysis of the results of the retention test presented on Table 4 showed that the experimented group had mean scores higher than the control group. Also, the analysis of covariance in retention test presented on Table 9 also confirmed that the difference in the mean scores of the students taught with AUTOTEDRACAD technique and those taught with demonstration method was significant. This indicated that AUTOTEDRACAD has a positive effect on student retention of learning technical drawing. This implies that Sequential Instruction, Multi-Sensory Presentation Surface Modeling, Problem Solving and Competency Based Evaluation are more effective than the demonstration method in enhancing students' retention in learning technical drawing.

This result is attributed to the fact that students remember more of what they learnt when the instruction appeal to more than one of their senses and more so AUTOTEDRACAD technique assist the students to organize lesson into well connected patterns and only few information occupies a few bits in the memory. Thus, having larger and better connected patterns frees the space in the working memory; this available space is used to reflect on new information which aids retention.

The result is in paripassu with the works of Dalton, Hannafin, Hopper (2003) that student scores on delayed test indicated that the retention of content by the learner using Computer Based Instruction is superior to retention following traditional instruction alone. Mackenzie and Jansen (2002) agreed that sensory sight, tones and hearing as in AUTOTEDRACAD aid in simulation, academic achievement and retention. The result of the study also agreed with the findings of Amuludun, Lemo and Usoro (2006) that students' retention and academic achievement was enhanced when multi-dimensional model was introduced in teaching and learning technical drawing. Amuludun et al attributed this to the fact that retention of information is enhanced when information is presented in logical sequence of event, one following the other until the whole subject is created as a network of interrelated data in a single visual image, couple with highly memorable illustrations and graphic diagrams to enhance retention. The result of this study could explain the fact that involving students in technique that stimulate learners to be active, providing clear feedback regarding the effectiveness of the learner, are likely to enhance retention process for a long time.

The analysis of covariance on significant interaction of AUTOTEDRACAD technique and areas of specialization of students' academic achievement in technical drawing on Table 8 showed that the null hypothesis was upheld. This means that there was no significant difference between the mean score of student in engineering and construction trade. The finding is in support of the work of Roth, Wozzozyns and Smith (1996) that computer and modeling software contribute to student interaction and learning. Thus, computer world contributes significantly in maintenance and coordination of students' interaction within the groups. In another study conducted by Dalton, Hannafin and Hopper (2003) they ascertained that those who worked cooperatively significantly outperformed those who work individually and their interaction were not observed between individual methods.

This finding explained the fact when a technique encourages the learner to relate their work in line with active and experiential learning, such techniques would stimulate the development of a range of communication skills which are central to design and developing of curiosity, enquiry, initiative, and ingenuity, resourceful and discerning skills among students. The finding further explained that computer enrich instructions are infinitely patient, never get tired, get frustrated and do not embarrass students who make mistakes, give immediate feedback, are more objective than teachers, and consistent in drill and practice, teach in small increments, eliminates the drudgery of doing certain learning activities by hand (e.g. drawing, graphic work). Ukoha 1996 and Onaga (2000) works agreed with the present study that instructional material interaction makes learning more meaningful and more effective as students' participation and productivity increases.

The analysis of covariance between the mean scores of student in engineering and construction trade in Technical Drawing Achievement Test (TDAT) presented on Table 6 showed that the null hypothesis was retained. This means that there was no significant different between the mean scores of students in engineering and construction trade. The finding of this study is in the same pace with the result obtained by Bangert-Drowns, Kulik and Kulik (2006) when they compared the effect of computer Aided Instruction in different curriculum areas, their result indicated that there was no significant difference in academic achievement among students as CAI activities are more interactive in the areas of science, technology and foreign language.

The result of finding explained the fact that when students are exposed to learning that would take place in authentic and real world environment, content and skills being relevant and teachers serve as guides and facilitators of learning and not instructors in academics. Academic achievement is likely to be active, competitive and enhanced.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Re- Statement of the Problem

One of the primary goals of technical drawing is to facilitate the development of skills related to reading, interpretation of drawings, recognizing drawing in one form and where required change it into more applicable form. Thus, making use of conventional symbols and applying the principles of drawing to the construction of everything in the society.

Accordingly, Mackenzie and Jansen (2002) observed that technical students have difficulty understanding certain fundamental concept such as those associated with technical graphic, often, the problem as Mackenzie et al (2002) noted that this problem does not lie with students' inability to visualize or comprehend spatial relationships but with the limitations of conventional tools and techniques in drafting instruction.

Many of the traditional drawing tools e.g. still images, transparencies, chalkboard with large manual drawing instrument and physical mock-ups offer limited utility when used to teach difficult and complex concepts, another difficulty is the time required to present complex concepts and solve complicated drafting problem by using large-format, manual-drawing instrument on the chalkboard, as a number of concept that need to be covered in technical drawing continues to increase traditional instruction and tools fall short of accomplishing, the intended objectives. The limitation encountered in the traditional method of instruction has accounted for low knowledge and skill in Technical Drawing.

The poor instructional method is partly responsible for the decline in students' learning of technical drawing as evidenced by their performance in both National Technical and Business Examination Board (NABTEB) in technical drawing in recent years (Akpan (2000), Akpan (1999), Omeji (2001) and at their workplace when they are eventually employed on graduation (Harrizon 1996, Gypi 1991; Mackenzie and Jansen, Nwoke 1993, Vrinten 2002; Driscoll 2000; Kulik and kulik 2003).

The short-coming of the traditional method on students' achievement coupled with the increased necessity for flexible individuals in the work force with strong problem solving, critical thinking habits, multiple dynamically liked representation of the drawing concepts and student's self medication based on the effect of globalization lend support for computer enrich instruction of which Automated Technical Drawing Computer Associated drafting Technique (AUTOTEDRACAD) is based. Computer Assisted Design (CAD) has been applied to the works of scholars in physic, engineering and architectural design, but there is need to determine the effectiveness of AUTOTEDRACAD on the academic achievement and retention of students' in technical drawing.

Summary of Procedures used

The study adopted a quasi-experimental pretest-post test design and was aimed at determining the effects of Automated Technical Drawing Computer Assisted Drafting Technique on technical college year two students' academic achievement and retention in technical drawing. The specific objectives of the study were to

- Determine the effects of AUTOTEDRACAD technique on students' academic achievement and retention in technical drawing.
- Compare the Technical Drawing Achievement Test (TDAT) scores of students' (girls and boys) when taught with AUTOTEDRACAD technique.
- Determine the effects of AUTOTEDRACAD technique on students' (girls and boys) retention in the study of technical drawing.
- Determine the effects of AUTOTEDRACAD technique on students' retention in the study of technical drawing.

To achieve these objectives, four research questions and six null hypotheses were formulated. The population of the study was 2110 student of 2007/2008 technical year two students in all government own and private own technical colleges in Akwa Ibom State. Out of these 240 students from two arms of year two technical drawing students representing engineering and construction trades were purposively sampled. Instruments for data collection for the study, was:

(a) 50 items Technical Drawing Achievement Test constructed by the researcher.

(b) The instruments were validated by five experts drawn from the lecturers in the department of Vocational Teacher Education and Science Education, University of Nigeria, Nsukka and from Technical Education Department, University of Uyo.

A pretest was first administered to the two group followed by the treatment which lasted for five weeks. The post test was given at the end of the treatment and was followed two weeks later by retention test. The scores of each student in the entire test were compiled, mean and standard deviation were used to answer the research questions while analysis of covariance was used to test the six hypotheses at 0.05 level of significance.

Principal Findings

Based on the data collected and analyzed, the following principal findings were made.

(1) Students who were taught with Automated Technical Drawing Computer Assisted Drafting (AUTOTEDRACAD) technique were found to have significant mean score than those taught with demonstration method in achievement test.

(2) Although the mean scores of boys were higher than that of the girls in the post test, the difference was not high enough to be deemed significant. Therefore there was no significant difference between boys and girls in their achievement test.

(3) The mean score of girls were higher than that of the boys in retention; it was not higher enough to be significant. Therefore, there was no significant difference between boys and girls in their retention test.

(4) The experimental group students who were taught with the AUTOTEDRACAD technique of Sequential Instruction, Multi-Sensory Presentation, Surface Modeling, Problem Solving and Competency Based Evaluation were found to have higher scores than the control group students who were taught with the conventional demonstration method in the retention test.

(5) There was no significant interaction effect recorded between construction and engineering trade student. This show that the two groups; engineering and construction students taught AUTOTEDRACAD interact with the software equally in technical drawing achievement test.

Conclusion

Based on the result of the study, the following conclusions were made.

The instructional methods adopted by technical teachers greatly affect the learning of technical drawing. This is usually reflected in the academic achievement and retention of learning. The findings of the study showed that there is need to pay special attention to the training of technical students, hence, the adoption of AUTOTEDRACAD in technical drawing to enhance academic achievement and retention of learning. This implies that student learn better when they are exposed to multi-sensory presentation, thus they participate actively in the class by interacting with the learning material and more at their own pace with competency base assessment of themselves.

Also, Students retained their learning for a longer time when they are taught with AUTOTEDRACAD technique of Sequential Instruction, Multi-Sensory Presentation, Surface Modeling, Problem Solving and Competency Based Evaluation. It was also established that there is no significant different between boys and girls in their academic achievement and rate of retention of learning in technical drawing as such would not be necessary to provide different learning technique for any of the sexes. Thus, educating technical students to meet the growing standard in the labour market means working for a high level of creativity in technical education.

Implication of Study

The findings of this study have implications for technical drawing teachers, curriculum developers, Students Educational Administrators and Official of State Ministry and State Technical School Board. Having found that AUTOTEDRACAD technique has positive effects on students' academic achievement and retention in studying technical drawing, technical drawing teacher should adopt this technique in their teaching for optimum academic result. It further implies that technical teachers should pay careful attention to the gaps between boys and girls in academic achievement with the view to bridge the existing gap. Apart from the direct effect on academic achievement, this technique could considerably improve students' communication and creativity in technical drawing. It will also improve the manipulation and technical skills needed in workplace. It will also enhance learners in articulation of their knowledge and skills to learn factual information, simple discrimination, rules and application of drafting principles without stress of repetition and parrot fashion of learning student will develop logical skills in solving problem as well as self-directed learning and self-growth. The focus of teaching will be the one guiding the learner to build on and modify their existing mental model. It will save time and cater for diverse learning styles of students in technical drawing classroom.

The implication of the findings of the study to curriculum developers is that they should review technical drawing curriculum directly with the view to introduce AUTOTEDRACAD technique as it promotes the understanding in the application for graphic language. The implication for educational administration in both State Ministry of Education and State Technical Schools Board is that they should appreciate the need for the development of customized software, provision of modernized drafting tools and equipment and practices in technical drawing classroom in order to greatly enhance academic achievements and retention of facts among technical student.

Recommendations

- Technical teachers should be encourages to utilize AUTOTEDRACAD technique to cater for the diverse learning styles of student in technical drawing classroom and hence, improve their academic achievement and retention of learning.
- More women should be encouraged to enter the profession and advance to position of leadership in which they may serve as role models.
- Multimedia literacy must be emphasized as basic skills that will be as important to life in the 21st century.
- Enlightenment for an increase in girls' involvement in Technology Education must be ensured.
- Technical teachers should not only praise girls for their appearance and cleanliness, they should also be praised for their abilities, skills, creativity and ideas.
- Since employers require more knowledge and skills from the graduate of technical education than simple job skills, the students must be encouraged to prepare and be ready to function in collaborative setting,

interpret complex requirement and exhibit self directed, self assessing behaviour on the job.

- There should be a priority of massive training and retraining of technical teachers in technical colleges in the use of information and communication technology. This will keep the teachers abreast in the innovative pedagogy whereby the product of Technical Education will not be rode off as a result of simplistic and primitive routines when in this 21st century there are better technique for enhancing academic achievement and retention of student as in AUTOTEDRACAD
- Technical teachers should initiate technique that require students to process and apply new information as this technique strengthens the academic achievement and retention ability in students.
- The role of technical teacher should be that of a guide metaphor which motivates provides example, discusses, facilitates, supports and challenge but not to act as a director and transmitter of knowledge.
- Students should be encourage to become self regulatory, self-mediated and self aware. These activities involve metal manipulation and self-organization of experience and requires that student regulate their own cognition functions, mediate new meaning from existing knowledge and form an awareness of current knowledge structure.
- Technical Teacher should provide for and encourage multiple presentation and representation of content as this technique provide students with various routes for which to retrieve knowledge and have the ability to develop more complex schema relevant to the experience.

- Students learn best when actively making meaning of the material. It is important that students are encouraged in the use of this technique as it its promote a deeper thinking as student manipulates and interacts with the software addressing such question as how does it happen? Why does it happen? In what circumstances does it happen?
- Course content in technical drawing should be produced in computer software and present as such so to engage the learners in active learning mode in order to evolve interest, retention and academic and workplace skill.
- Teachers should be trained on the technique of AUTOTEDRACAD since it bridge the gap between school and wish, school and community, and also enable the transfer of knowledge and skills to a variety of situations.
- National Board for Technical Education should incorporate the techniques of AUTOTEDRACAD in technical drawing curriculum as it holds that knowledge comes as a result of interaction, the technical teacher should ensure that learning experiences is socially acquired through material-student's interaction.
- Technical teachers training institution with programme of industrial technical Education production should provide students with instruction on the issues related to creating and implementing AUTOTEDRACAD technique. The use of computer as a tool for presenting information will continue to grow in educational world. These tools are well suited for technical drawing and to deal with 2D-3D, images, illustration, drawings, models, animations and simulations.

- Technical teacher training institution should provide in-service training to technical graphic instructors that need assistance in software production.

Limitations of the Study

One of the limitations in this study was the inability to randomize the assessment of students into groups. The initial result of AUTOTEDRACAD was done on a small group of technical students and there was no other software to compare the software with another teaching. At this stage, the researcher could only conclude that AUTOTEDRACAD technique is at least promising and more in-depth studies are needed to prove its effectiveness or otherwise of the present study.

Suggestions for Further Studies

The future studies should separate the personality of the technique originator from the technique itself to prove its generalizabilty. This could be achieved using the model in a CAI form e.g. drawing slides, pictures, animation, and other multimedia potentials. This technique many prove to be useful supplement for problem learning.

The following topics have been suggested by the researcher for further studies:

- Effect of AUTOTEDRACAD technique on student interest and learning rate.
- Effect of AUTOTEDRACAD on locus of control and on students of different ability levels.
- Development and validation of computer based technique in different curricular area in technical drawing.

- Development and validation of instructional time on task computer technique in technical drawing instruction.

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APPENDICES

APPENDIX A

Distribution of the Population of Students according to State Technical Schools Board in Akwa Ibom State

S/N	Names of School	T^2 Enrolment
1.	Government Technical College, Ewet - Uyo	200
2.	Mainland Technical College - Oron	180
3.	Ekasus Secondary and Technical School - Nduetong	160
4.	Slawd Peters Comprehensive Secondary (Technical) School - Etinan	150
5.	Eket Vocational Training School - Eket	195
6.	College of Science - Afaha Oku	165
7.	Government Technical College - Abak	200
8.	Kings Technical College – Uyo	260
9	Community Technical College- Ikot Akata	215
10	Union Technical College Ikpa Eket	185
11	Government Technical College- Ikot Uko Ika	200
	Total	**2110**

APPENDIX B

Subject Group Distribution according to Name of School, Type and Number of Subject

S/N	Names of School	Group	Type of Group	Number of Student
1.	Government Technical College, Ewet – Uyo	A	Experimental and Control	30 30
2.	Mainland Technical College – Oron	B	Experiment and Control	30 30
3.	Ekasus Secondary and Technical School - Nduetong	C	Experimental and Control	30 30
4.	Eket Vocational Training School – Eket	D	Experimental and Control	30 30
				240

APPENDIX C

Automated Technical Drawing Computer Assisted Drafting (AUTOTEDRACAD Techniques and the Actual Treatment that was given to the Students.

AUTOTEDRA CAD Techniques	**Actual Treatment to Students**	**Emphasis Covered**
Sequential Instruction	Allow students to follow certain instructional sequence, the student uses the material as a discovery learning resources. With AUTOTEDRACAD tools it allows the learners to articulate their knowledge. It teaches factual information, simple discrimination, rules and simple application of rules	Academic Achievement
Surface Modeling	It equipped the learners with an attempt to model an object on a computer, so that it could be studied how it works. It provides safe experimental learning not possible in the real world. It allows the students to imitate real thing, state of affairs which will sometimes be exposed to in the real world.	Retention and Academic Achievement
Problem Solving	It aids the students how the opportunity to develop a plan of action through trial and error approach. It helps the students to develop logical thinking in solving problem. It directs the learners towards extractions, making explicit and practicing problem solving	Retention and Academic Achievement
Multi-sensory Presentation	It helps the students to learn concepts of a real principle as it combines oral explanation. It shows and tells how to do something step by step. It provides the student with the act of visual experiences with proof or evidence on how something is done and is the best supportive tool to introduce new information.	Retention and Academic Achievement
Competency Based Evaluation	This allows the teacher to plan and adapt instruction to meet the specific needs of each student. It enhances learning and foster students' growth in the stated behavioural objectives. This tool assesses student strength and identifies areas of improvement. It monitors progress, adjusts instruction accordingly, ensures prompt review of lesson for remedial consideration, and encourages mastery learning.	Feedback/Academic achievement

APPENDIX D

STUDENTS' ANSWER SHEET FOR ANSWERING TECHNICAL DRAWING ACHIEVEMENT QUESTIONS.

INSTRUCTIONS:

1. Do not write your name but write your number of the class register.
2. Tick (√) against the letter (A - D) that corresponds with the answer that you choose on the question sheet.
3. Erase neatly if you have change your mind.
4. Use HB pencil only.

Pretest Answer Sheet

1.	A ( )	B ( )	C ( )	D ( )	26.	A ( )	B ( )	C ( )	D ( )
2.	A ( )	B ( )	C ( )	D ( )	27.	A ( )	B ( )	C ( )	D ( )
3.	A ( )	B ( )	C ( )	D ( )	28	A ( )	B ( )	C ( )	D ( )
4.	A ( )	B ( )	C ( )	D ( )	29.	A ( )	B ( )	C ( )	D ( )
5.	A ( )	B ( )	C ( )	D ( )	30.	A ( )	B ( )	C ( )	D ( )
6.	A ( )	B ( )	C ( )	D ( )	31.	A ( )	B ( )	C ( )	D ( )
7.	A ( )	B ( )	C ( )	D ( )	32	A ( )	B ( )	C ( )	D ( )
8.	A ( )	B ( )	C ( )	D ( )	33.	A ( )	B ( )	C ( )	D ( )
9.	A ( )	B ( )	C ( )	D ( )	34.	A ( )	B ( )	C ( )	D ( )
10.	A ( )	B ( )	C ( )	D ( )	35.	A ( )	B ( )	C ( )	D ( )
11.	A ( )	B ( )	C ( )	D ( )	36.	A ( )	B ( )	C ( )	D ( )
12.	A ( )	B ( )	C ( )	D ( )	37.	A ( )	B ( )	C ( )	D ( )
13.	A ( )	B ( )	C ( )	D ( )	38.	A ( )	B ( )	C ( )	D ( )

14.	A ( )	B ( )	C ( )	D ( )	39.	A ( )	B ( )	C ( )	D ( )
15.	A ( )	B ( )	C ( )	D ( )	40.	A ( )	B ( )	C ( )	D ( )
16.	A ( )	B ( )	C ( )	D ( )	41	A ( )	B ( )	C ( )	D ( )
17.	A ( )	B ( )	C ( )	D ( )	42.	A ( )	B ( )	C ( )	D ( )
18.	A ( )	B ( )	C ( )	D ( )	43	A ( )	B ( )	C ( )	D ( )
19.	A ( )	B ( )	C ( )	D ( )	44.	A ( )	B ( )	C ( )	D ( )
20.	A ( )	B ( )	C ( )	D ( )	45.	A ( )	B ( )	C ( )	D ( )
21.	A ( )	B ( )	C ( )	D ( )	46.	A ( )	B ( )	C ( )	D ( )
22	A ( )	B ( )	C ( )	D ( )	47.	A ( )	B ( )	C ( )	D ( )
23	A ( )	B ( )	C ( )	D ( )	48.	A ( )	B ( )	C ( )	D ( )
24	A ( )	B ( )	C ( )	D ( )	49.	A ( )	B ( )	C ( )	D ( )
25	A ( )	B ( )	C ( )	D ( )	50.	A ( )	B ( )	C ( )	D ( )

The above same answer sheet will be given for the post test

APPENDIX E

Technical Drawing Achievement Test (TDAT)

INSTRUCTIONS;

1. Attempt all questions.
2. There are four options A - D following each question. You are to choose right answer for each question.
3. Erase or cancel earlier answer neatly if you change your mind.
4. Use only the provided answer sheets for your answers.
5. Attempt these questions independently as possible.
6. Do not write your name or class register number on the question paper.

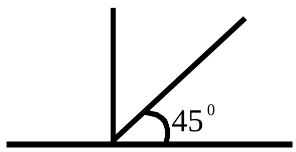
Pre Test Items

1. The type of drawing which shows how parts are positioned relatively to one another is called. (a)Production drawing (b) Functional drawing (c) Assembly drawing. (d) Pictorial drawing

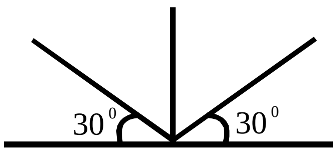
2. The type of pictorial drawing representing an object in three-dimensional views with converging lines as it appears to the eye is (a) Axonometric (b) Perspective (c) Isometric (d) Orthographic

3. Which of the following is correct about oblique drawing?

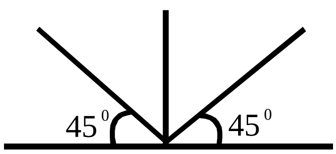
(a)



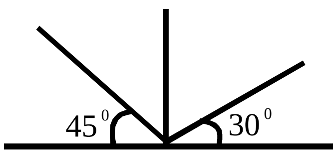
(b)



(c)



(d)



4. The statement that best describes auxiliary projection is:
(a) projection of vertical plane at right angle
(b) projection of horizontal plane at right angle
(c) projection of vertical and horizontal planes at right angle
(d) projection of regular outlines at right angle

5. Thick continuous line is used for
(a) Visible outline and viewing plane (b) Visible outline and final shape of edge (c) Cutting plane and outline (d) Construction and centre line

6. The statement that *"the left hand side of an elevation will be drawn to the right of that elevation best describe"*.
(a) First angle projection (b) Second angle projection
(c) Third angle projection (d) Fourth angle projection

7. A straight line joining the centre of a circle on any point on the circumference is called (a) Diameter (b) Chord (c) Radius (d) Circumference

8. Using a scale of 1:1 implies that the object will be in
(a) Full size (b) half size (c)enlarge size (d)equal size

9. Orthographic projection is a form of drawing use for:
(a) Assembly drawing only (b) draughtsman sketches only (c) representation of drawing (d) working drawing (d) Drawing in fieldwork.

10. The type of dimension used to ensure complete interchangeability of parts is called (a) Functional dimension (b) Tolerance dimension
(c) Auxiliary dimension (d) complete dimension

11. An auxiliary view projected from an elevation will produce a/an
(a) End elevation (b) Front elevation (c) Plan (d) End and front elevation

12. The line drawn below is used for

(a) broken line (b) short dashes (c) center line (d) odd line

13. One of the best advantages of datum measurement is: (a) Error do not occur (b) All measurement are derived from the datum
(c) It out class chain measurement
(d) Accumulated measurement is ensured.

14. Which of the following method is the best to dimension holes?
(a) Use of dots with lines (b) Use of arrow heads with line
(c) Use of thin line with numbers (d) Use of sharp pencil with rule

15. All expect one is the means of specifying measurement on part of a component. (Diametric) (b) diateric (c) dimension (d)width

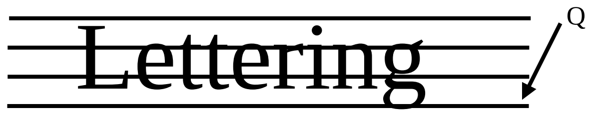
16. A straight line that is drawn at right angle to the diameter of the circle best describes ; (a) circle (b)segment (c) Tangent (d) radius

17. ----------- has a straight line but no area.
(a)Line (b) dot (c) datum (d) leader

18. An auxiliary plane is usually signified by
(a) X1 - X1 (b) A – A (c) B – B (d) C - C

19. One of these is not an advantage of auxiliary projection
(a) It determines true shape of object
(b) It determines volume of space
(c) It describes solid figure
(d) It describes irregular outlines

20. Which of the following types of drawing in NOT pictorial in nature?
(a) Isometric (b) Perspective (c) Orthographic
(d) Diametric

21. 

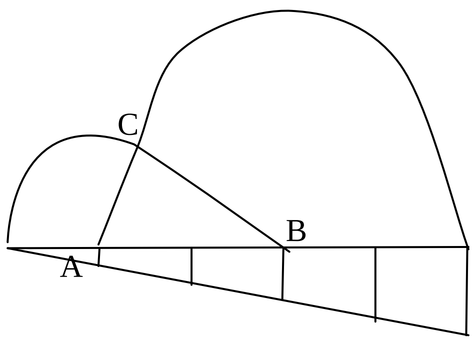
In lettering, line *"Q"* as shown above indicates
(a) Base Line (b) Drop Line (c) Waist Line (d) Leg Line

22 Sectioning is expressed in drawing by
(a) Thin lines (b) Broken lines (c) Hatching lines (d) Curved

23 An auxiliary drawing will require the use of one of these planes
(a) Vertical Cutting plane (b) Horizontal Cutting plane (c) Oblique Cutting plane (d) Perpendicular Cutting plane

24. The true surface formed by cutting a cylinder at angle 30^0 is
(a) Circle (b) Rectangle (c) Ellipse (d) Square

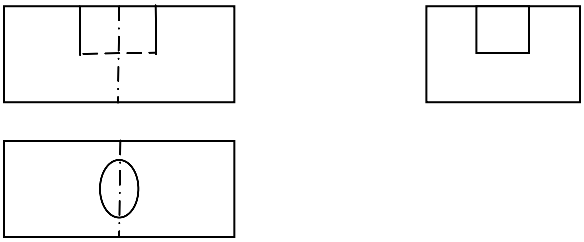
25. The triangle ABC shown below is in the ratio of



(a) 2:2:1 (b) 2:6:1 (c) 3:6:2 (d) 4:2:1

26. Dimension line which is nearest the outline should be about ---- mm from it (a)6mm (b) 8mm (c) 10mm (d) 12mm

27. State the angle of projection of the orthographic drawing shown below

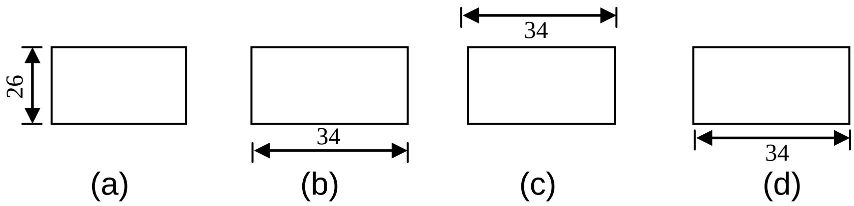


(a) First Angle (b) Third Angle (c) Fourth Angle
(d) Second Angle

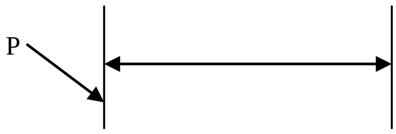
28. Lines that are drawn from points on the drawing and the dimension lines are placed between them best describes;
(a) Dimension line (b) projection line (c) leader line
(d) Overall line

29. The view on vertical plane of an orthographic projection is called
(a) Plan (b) Elevation (c) End Plane (d) Sectional Plan

30. Which of these options is a good method of showing a dimension?



31. In the diagram shown below, the line indicated by the arrows *"P"* is called

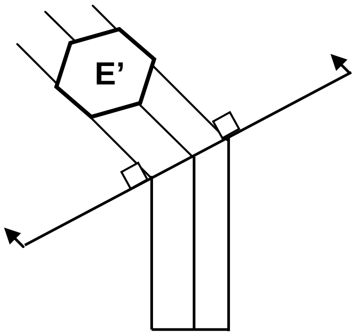


(a) Section Line (b) Extension Line (c) Visible Line (d) Dimension Line

32. Using a block with sizes (450 x 225 x 225) mm, sketch to show the arrangement of 1st angle orthographic projection

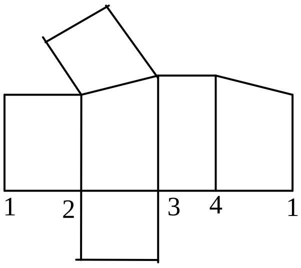
33. The principal factor used in the classification of auxiliary views is
(a) Dimension (b) Axis (c) Geometry (d) Volume

34. Use the figure below to answer the question



The View labelled *"E"* is known as
(a) Auxiliary (b) Inclined View (c) Oblique View (d) Projected View

35. The figure below shows the development of a



(a) Truncated Prism (b) Square Prism (c) Frustum of Hexagonal Prism
(d) Frustum of a Cylinder

36. In the relationship between planes of projection, front elevation is produced from----

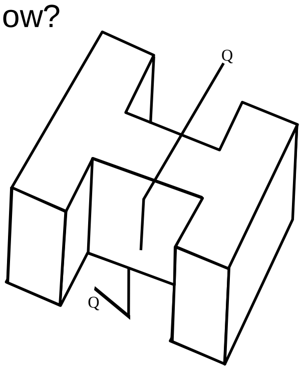
(a) Frontal plane,

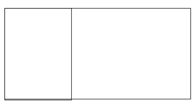
(b) Horizontal plane

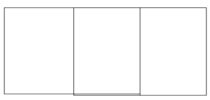
(c) Vertical plane

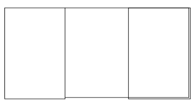
(d) Profile plane

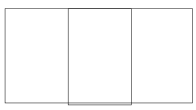
37. Which of the following represent section Q – Q in the diagram shown below?



(a) 

(b) 





(c) (d)

38. Straight line that is drawn across the circle meeting the circumference at both ends is----
(a) Arc (b) Chord (c) Sector (d) Quadrant

39. One of these is not the application of a revolved sectioning
(a) The cutting plane passes through the part of right angle to the axis
(b) The cutting plane revolved about its axis of symmetry
(c) The sectional view passes through the object at an angle of 60^0
(d) The cutting plane quickly conveys information

40. Thick lines are usually expressed as
(a) Construction lines (b) Outlines (c) Dimension lines
(d) Hidden lines

41. When labeling an object, lettering is not usually
(a) Inclined (b) characterized (c) Underlined () Uppercased

42. A plane figure is defined by
(a) Area only (b) Volume only (c) Length only
(d) Area and Volume only

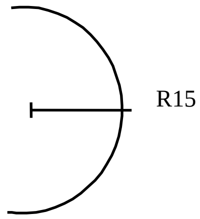
43. All except one is not a method of developing an object
(a) Parallel lines (b) Off set lines (c) Radial lines (d) Triangular lines

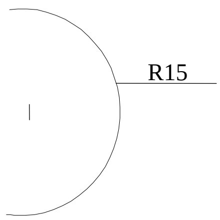
44. Lines of intersection of two meeting surfaces could be determined through
(a)Meeting of surface at the vertex
(b) Meeting of the intersections
(c) Intersection of prism and pyramid
(d) Meeting of equal diameter

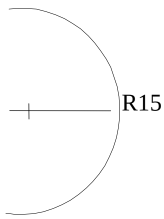
45. When the front elevation of an object is directly below the plan, the angle of projection is (a) 1st angle (b) 2nd angle (c) 3rd angle (d) 4th angle

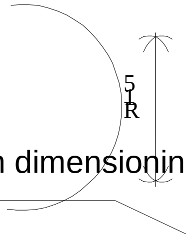
46. The principal views used in orthographic projection are front view, end view and (a) Oblique view (b) Isometric view (c) Pictorial view (d) Plan view

47. The correct method of dimensioning an arc is

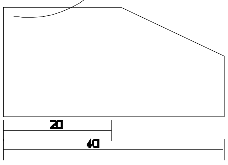
(a) 

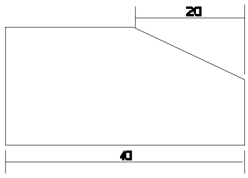
(b) 

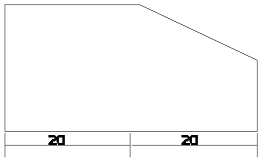
(c) 

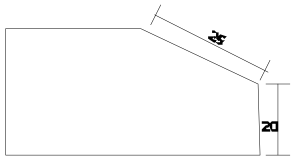
(d) 

48. Datum dimensioning is shown in

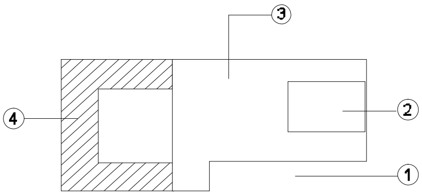
(a) 

(b) 

(c) 

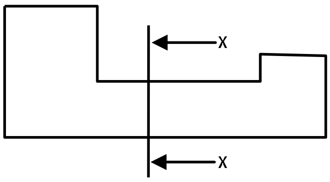
(d) 

49. In the diagram below, sectioning is applied at



(a) 1 (b) 2 (c) 3 (d) 4

50. Section x – x in the diagram below will reveal



(a) Full section (b) Half section (c) Off-set section
(d) Revolved section

Post Test

1. An auxiliary view projected from an elevation will produce a/an
(a) End elevation (b) Front elevation (c) Plan (d) End and front elevation

2. The type of drawing which shows how parts are positioned relatively to one another is called (a) Production drawing (b) Functional drawing (c) Assembly drawing (d) Pictorial drawing.

3. One of the best advantages of datum measurement is: (a) Error do not occur (b) All measurement are derived from the datum
(c) It out class chain measurement

(d) Accumulated measurement is ensured.

4. Which of the following method is the best to dimension holes?
   (a) Use of dots with lines (b) Use of arrow heads with line
   (c) Use of thin line with numbers (d) Use of sharp pencil with rule

5. All expect one is the means of specifying measurement on part of a component. (Diametric) (b)diater (c) dimension (d)width

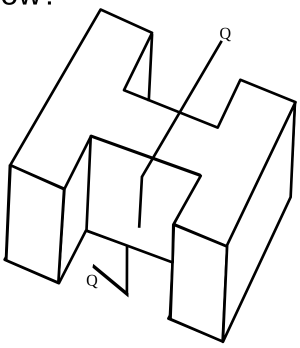
6. In the relationship between planes of projection, front elevation is produced from----
   (a) Frontal plane,

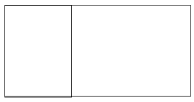
   (b) Horizontal plane

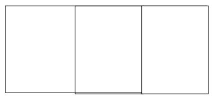
   (c) Vertical plane

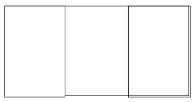
   (d) Profile plane

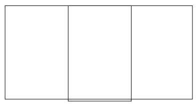
7. Which of the following represent section Q – Q in the diagram shown below?



(a) 

(b) 

(c) 

(d) 

8. Straight line that is drawn across the circle meeting the circumference at both ends is----
   (a) Arc (b) Chord (c) Sector (d) Quadrant

9. One of these is not the application of a revolved sectioning
   (a) The cutting plane passes through the part of right angle to the axis
   (b) The cutting plane revolved about its axis of symmetry
   (c) The sectional view passes through the object at angle 60 and angle 90
   (d) The cutting plane quickly conveys information

10. Thick lines are usually expressed as
    (a) Construction lines (b) Outlines (c) Dimension lines
    (d) Hidden lines

11. A straight line that is drawn at right angle to the diameter of the circle best describes; (a) circle (b) segment (c) Tangent (d) radius

12. ----------- has a straight line but no area.
    (a)Line (b) dot (c) datum (d) leader

13. An auxiliary plane is usually signified by
(a) X1 - X1 (b) A – A (c) B – B (d) C - C

14. One of these is not an advantage of auxiliary projection
(a) It determines true shape of object
(b) It determines volume of space
(c) It describes solid figure
(d) It describes irregular outlines

15. Which of the following types of drawing in NOT pictorial in nature?
(a) Isometric (b) Perspective (c) Orthographic
(d) Diametric

16 When labeling an object, lettering is not usually
(a) Inclined (b) characterized (c) Underlined () Uppercased

17. A plane figure is defined by
(a) Area only (b) Volume only (c) Length only
(d) Area and Volume only

18. All except one is not a method of developing an object
(a) Parallel lines (b) Off set lines (c) Radial lines (d) Triangular lines

19. Lines of intersection of two meeting surfaces could be determined through
(a)Meeting of surface at the vertex
(b) Meeting of the intersections
(c) Intersection of prism and pyramid
(d) Meeting of equal diameter

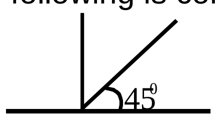
20. When the front elevation of an object is directly below the plan, the angle of projection is (a) 1st angle (b) 2nd angle (c) 3rd angle
(d) 4th angle

21. The type of drawing which shows how parts are positioned relatively to one another is called. (a)Production drawing (b) Functional drawing
(c) Assembly drawing. (d) Pictorial drawing

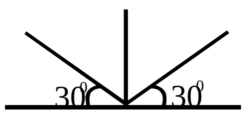
22. The type of pictorial drawing representing an object in three-dimensional views with converging lines as it appears to the eye is
(a) Axonometric (b) Perspective (c) Isometric (d) Orthographic

23. Which of the following is correct about oblique drawing?

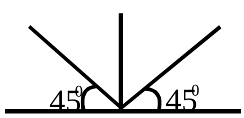
(a)



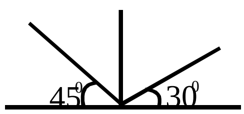
(b)



(c)



(d)



24. The statement that best describes auxiliary projection is:
(e) projection of vertical plane at right angle
(f) projection of horizontal plane at right angle
(g) projection of vertical and horizontal planes at right angle
(h) projection of regular outlines at right angle

25. Thick continuous line is used for
(a) Visible outline and viewing plane (b) Visible outline and final shape of edge (c) Cutting plane and outline (d) Construction and centre line

26. Dimension line which is nearest the outline should be about ---- mm from it (a)6mm (b) 8mm (c) 10mm (d) 12mm

27. The statement that *"the left hand side of an elevation will be drawn to the right of that elevation best describe"*.
(a) First angle projection (b) Second angle projection
(c) Third angle projection (d) Fourth angle projection

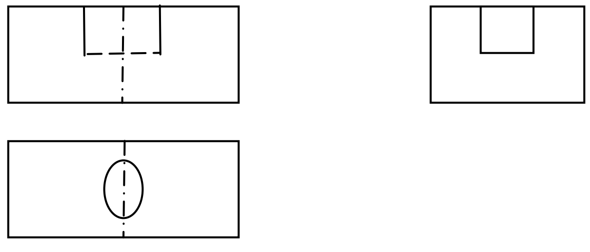
28. A straight line joining the centre of a circle on any point on the circumference is called (a) Diameter (b) Chord (c) Radius (d) Circumference

29. Using a scale of 1:1 implies that the object will be in
(a) Full size (b) half size (c)enlarge size (d)equal size

30. Orthographic projection is a form of drawing use for:
(a) Assembly drawing only (b) draughtsman sketches only (c) representation of drawing (d) working drawing (d) Drawing in fieldwork.

31. The type of dimension used to ensure complete interchangeability of parts is called (a) Functional dimension (b) Tolerance dimension (c) Auxiliary dimension (d) complete dimension

32. State the angle of projection of the orthographic drawing shown below

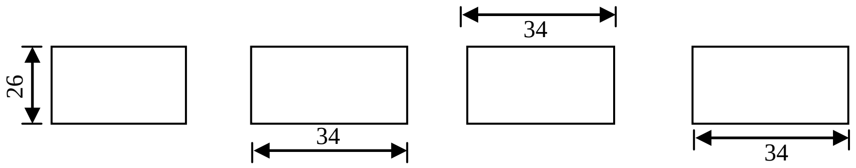


(a) First Angle (b) Third Angle (c) Fourth Angle
(d) Second Angle

33. Lines that are drawn from points on the drawing and the dimension lines are placed between them best describes;
(a) Dimension line (b) projection line (c) leader line
(d) Overall line

34. The view on vertical plane of an orthographic projection is called
(a) Plan (b) Elevation (c) End Plane (d) Sectional Plan

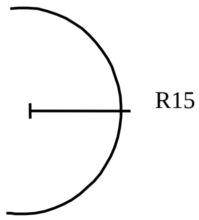
35. Which of these options is a good method of showing a dimension?

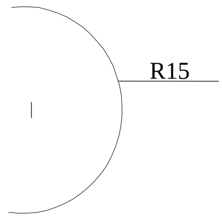


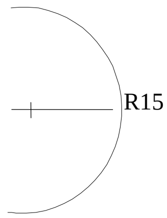
(a) (b) (c) (d)

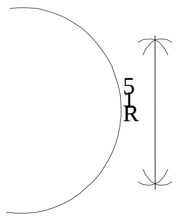
36. The principal views used in orthographic projection are front view, end view and (a) Oblique view (b) Isometric view (c) Pictorial view (d) Plan view

37. The correct method of dimensioning an arc is

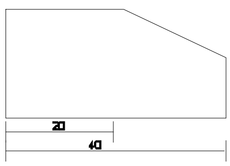
(a) 

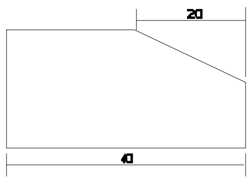
(b) 

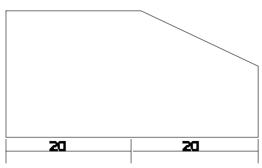
(c) 

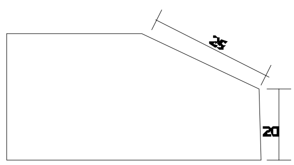
(d) 

38. Datum dimensioning is shown in

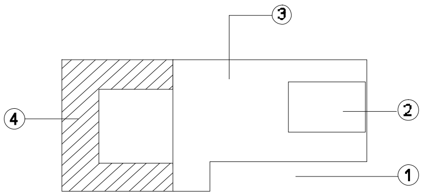
(a) 

(b) 

(c) 

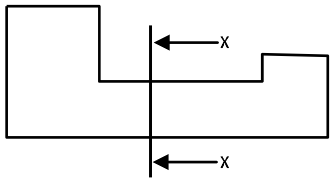
(d) 

39. In the diagram below, sectioning is applied at

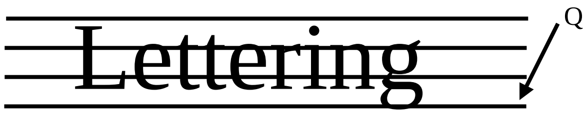


(a) 1 (b) 2 (c) 3 (d) 4

40. Section x – x in the diagram below will reveal



(a) Full section (b) Half section (c) Off-set section
(d) Removal section

41. 

In lettering, line *"Q"* as shown above indicates

(a) Base Line (b) Drop Line (c) Waist Line (d) Leg Line

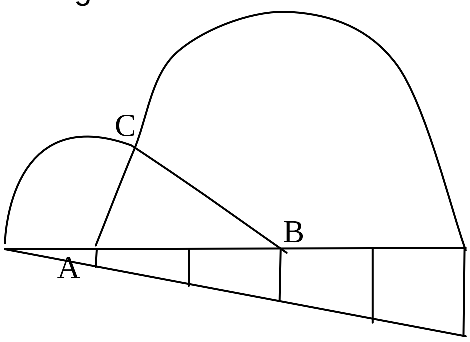
42 Sectioning is expressed in drawing by
(a) Thin lines (b) Broken lines (c) Hatching lines (d) Curved

43 An auxiliary drawing will require the use of one of these planes

(a) Vertical Cutting plane (b) Horizontal Cutting plane (c) Oblique Cutting plane (d) Perpendicular Cutting plane

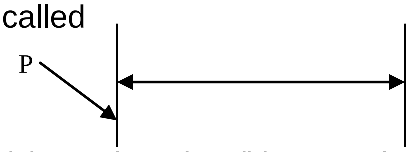
44. The true surface formed by cutting a cylinder at angle 30^0 is
(a) Circle (b) Rectangle (c) Ellipse (d) Square

45. The triangle ABC shown below is in the ratio of



(a) 2:2:1 (b) 2:6:1 (c) 3:6:2 (d) 4:2:1

46. In the diagram shown below, the line indicated by the arrows *"P"* is called

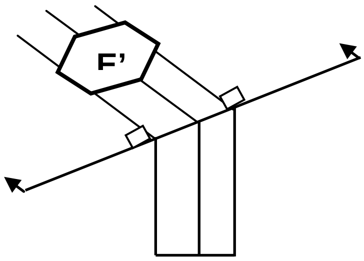


(a) Section Line (b) Extension Line (c) Visible Line (d) Dimension Line

47. Using a block with sizes (450 x 225 x 225) mm, sketch to show the arrangement of 3rd angle orthographic projection

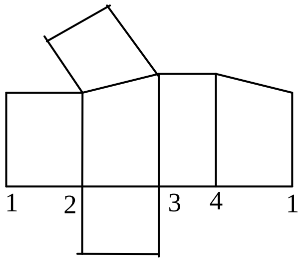
48. The principal factor used in the classification of auxiliary views is
(a) Dimension (b) Axis (c) Geometry (d) Volume

49. Use the figure below to answer the question



The View labelled *"E"* is known as
(a) Auxiliary (b) Inclined View (c) Oblique View (d) Projected View

50. The figure below shows the development of a



(a) Truncated Prism (b) Square Prism (c) Frustum of Hexagonal Prism
(d) Frustum of a Cylinder

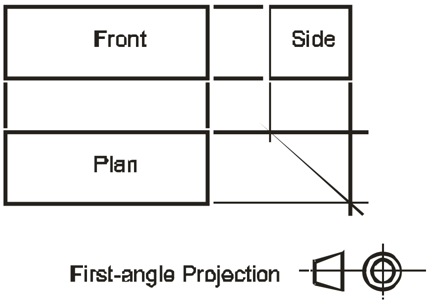
Model Answers

S/No	Pretest	S/No	Pretest	S/No	Posttest	S/No	Posttest
1.	A	26.	D	1.	D	26.	D
2.	C	27.	A	2.	C	27.	A
3.	A	28.	B	3.	A	28.	B
4.	D	29.	B	4.	B	29.	B
5.	B	30.	B	5.	C	30.	B
6.	A	31.	B	6.	A	31.	D
7.	A			7.	D	32.	A
8.	A	33.	B	8.	B	33.	A
9.	D	34.	A	9.	C	34.	A
10.	A	35.	A	10.	B	35.	D
11.	D	36.	A	11.	D	36.	D
12.	C	37.	D	12.	A	37.	A
13.	A	38.	B	13.	A	38.	A
14.	B	39.	C	14.	C	39.	D
15.	C	40.	B	15.	C	40.	D
16.	D	41.	D	16.	D	41.	A
17.	A	42.	A	17.	A	42.	C
18.	A	43.	B	18.	B	43.	C
19.	C	44.	A	19.	A	44.	A
20.	C	45.	A	20.	A	45.	A
21.	A	46.	D	21.	A	46.	B
22.	C	47.	A	22.	C		
23.	C	48.	A	23.	A	48.	B
24.	C	40.	D	24.	D	40.	A
25.	A	50.	D	25.	B	50.	A

Model Answers to hands on activity

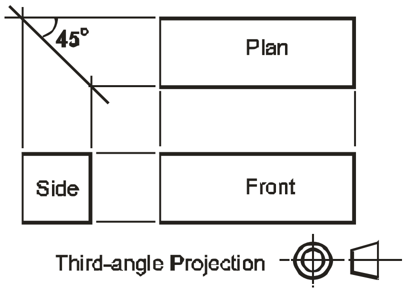
No. 32

Pretest



No. 47

Post-test



APPENDIX F: CONVENTIONAL LESSON PLAN 1

Subject: Technical Drawing
Topic: Forms 0f Drawing and Its Application
Class: Technical Student 2 **Age of Students:** 14-16 years
Duration: 45 mins **Date:**
Specific Objectives:

At the end of the lesson, students should be able to

(1) Describe drawing as a language of communication
(2) Explain and identify by sketch forms of drawing
(3) Express pictorial drawing as a 3 dimensional view
(4) State advantages of the forms of drawing
(5) Practically express pictorial and orthographic drawing

Entry Behaviour: The Student must have seen a road sign of two children with a school bag, or a hospital bed with crises.

Instructional Materials: Drawing Instrument

Instructional Procedure

Step	Content	Teacher's Activity	Student's Activity
1.	Uses of drawing as a language of communication (road signs and sign post)	Describe the use of drawing as a language of communication	Listen to the teacher and take note
2.	Forms of drawing (perspective, pictorial, oblique, and axonometric)	Identify at least three forms of drawing	Listen to the teacher, ask question and take note on those forms identified.
3.	Application of various forms of drawing in 3D.	State the application of the 3D drawing in the manufacturing industry	Listen to the teacher, ask question and take note
4.	Advantages of forms of drawing	List various advantages of drawing.	Listen to the teacher and jot down note
5.	Sketch the pictorial and orthographic forms drawing	Draw two forms of drawing	Learn to draw the forms of drawing.
6.	Evaluation	Answer the following question: (1) Explain the use of drawing as a language of communication. (2) Identify three forms of drawing. (3) Draw two forms of drawing	Attempt all questions.

5.	Summary	Recapitulate the whole lesson	Listen to the teacher and ask question

CONVENTIONAL LESSON PLAN 2

Subject: Technical Drawing
Topic: The application of the alphabet, lines and various forms of lettering.
Class: Technical Student 2 **Age of Students:** 14-16 years
Duration: 1:30mins **Date:**
Specific Objectives:
At the end of lesson presentation, the students should be able to
(1) Identify types of lines and state position of usage
(2) describe lettering and state it application
(3) State importance requirement for lettering
(4) Practical application on lettering

Entry Behaviour: The Student must have drawn lines in their exercise book, or seen line drawn to demarcate object or across it.

Instructional Materials: chalkboard and chalk
Instructional Procedure

Steps	**Content**	**Teacher's Activity**	**Student's Activity**
	Set Induction	**Review the Previous Lesson**	**Listen to the teacher**
1.	Various lines in technical drawing (hidden, thin, center line, and broken lines)	Identify various types of lines used in technical drawing.	Listen to the teacher and take note.
2.	Application of lettering	Draw correctly various types lettering.	Learn to draw types of line.
3.	Important requirement of lettering.	State different types of lives where it could be require in technical drawing.	Listen to the teacher list; take note and ask question.
4.	Evaluation	Answer the following questions: (1) Identify at least 3 types of lines (2) Draw correct 4 types of lines (3) State at least 2 types of lettering used in technical drawing	Attempt the questions
5.	Summary	Recapitulate the whole	Listen to the teacher

		lesson	and ask question

CONVENTIONAL LESSON PLAN 3

Subject: Technical Drawing
Topic: Symbols and conventions.
Class: Technical Student 2 **Age of Students:** 14-16 years
Duration: 1:30mins **Date:**
Specific Objectives: At the end of lesson presentation, the students should be able to:

(1) Illustrate with sketches symbols and conventions for engineering materials
(2) Illustrate with sketches symbols and convention for building materials
(3) Illustrate with sketches symbols and convention for electrical materials
(4) Draw orthographic projection of nut and bolt

Entry Behaviour: The Student must have seen various shapes and figure such as sphere, cones, circles, triangles.

Instructional Materials: set square, rule, compass and dividers

Instructional Procedure

Steps	Content	Teacher's Activity	Student's Activity
	Set Induction	**Review the Previous Lesson**	**Listen to the teacher**
1.	symbols and conventions for engineering materials	Identify various symbols and conventions in engineering material	Listen to the teacher and take note.
2.	symbols and conventions for building materials	Illustrate with sketches various types of symbols and conventions in building.	Learn to sketch the symbols and conventions in building.
3.	symbols and conventions for electrical materials	Illustrate with sketches various types of symbols and conventions in electrical	Listen to the teacher list and take note.
4.	Drawing of Nut and Bolt	Carry out drawing of nut and bolt	Learn to draw nuts and bolts constructs
4.	Evaluation	Answer the following questions: (1) Identify with sketch at least three symbols from engineering. building .and electrical material (2) Sketch a nut and a bolt	Attempt all questions
5.	Summary	Review the whole lesson	Listen to the teacher

CONVENTIONAL LESSON PLAN 4

Subject: Technical Drawing
Topic: Intersection and Development
Class: T^2 **Age of Students:** 14-16 years
Duration: 1:30mins **Date:**
Specific Objectives: At the end of lesson presentation, the students should be able to:

(1) Determine lines of intersection of the meeting surfaces
(2) Describe methods of development
(3) Practical application of developing simple surface

Entry Behaviour: In the previous lesson the students were taught simple geometric solid.

Instructional Materials: set-squares, ruler, compass and dividers

Instructional Procedure

Steps	Content	Teacher's Activity	Student's Activity
	Set Induction	Review the previous lesson	Listen to the teacher
1.	Determination for lines of intersection	Demonstration on lines of intersection	Learn to determine various lines of intersection.
2.	Describe methods of development	Teacher Describes method of development.	The students ask question and learn methods of development'
3.	Practical application of simple surface	Teachers draw to show students the practical application on simple surface.	Learn to draw simple application on simple surface.
4.	Evaluation	Answer the following questions: (1) sketch to show lines of intersection of a cylinder (2) develop a simple surface of a cone.	Attempt all questions.
5.	Summary	Review the whole lesson	Listen to the teacher and ask question

CONVENTIONAL LESSON PLAN 5

Subject: Technical Drawing
Topic: Principles of loci
Class: T^2 **Age of Students:** 14-16 years
Duration: 1:30mins **Date:**
Specific Objectives: At the end of lesson presentation, the students should be able to:

(1) Define terms associated with circles
(2) Construct and read plane scale
(3) Construct Geometrical tangency

Entry Behaviour: In the previous lesson the students were taught simple geometric solid.

Instructional Materials: set-squares, ruler, compass and dividers

Instructional Procedure

Steps	Content	Teacher's Activity	Student's Activity
	Set Induction	Review the previous lesson	Listen to the teacher
1.	Definition on parts of a circle	Define circle and its parts	Listen to the teacher and take note
2.	Construct and read plane scale.	Construct simple scale and read up to 4.5m	Learn to construct different scale for reading.
3.	construction of tangency	show with a sketches different tangency	Learn to sketch different type of tangency.
4.	Evaluation	Answer the following question: (1) Define sector. (2) Construct engine casket. (3) Sketch a circle and name it parts.	Attempt all questions.
5.	Summary	Review the whole lesson	Listen to the teacher and ask question

CONVENTIONAL LESSON PLAN 6

Subject: Technical Drawing
Topic: Principles of orthographic projection.
Class: T^2 **Age of Students:** 14-16 years
Duration: 1:30mins **Date:**
Specific Objectives: At the end of lesson presentation, the students should be able to:

(1) Define Orthographic Projection
(2) Describe the concepts of 1st & 3rd angle projection
(3) Identify the principal planes of projection

Entry Behaviour: Student must have been dragging a box of matches or a cement block being used by builders in building.

Instructional Materials: chalkboard and drawing instrument.

Instructional Procedure

Steps	Content	Teacher's Activity	Student's Activity
	Set Induction	**Review the previous lesson**	**Listen to the teacher**
1.	Definition of orthographic projection	Discuss the meaning of orthographic projection	Listen to the teacher, ask question and take note
2.	Describe concept of 1st& 3rd angle projection,	The teacher explains concepts of projection.	Learn, listen and describe principles of projection
3.	Principal planes of projection (vertical, horizontal and profile planes)	Sketch pictorial view of real object in first angle and third angle	Learn to relate the various pictorial views of 1st and 3rd
4.	Evaluation	Answer the following question: (1) What is orthographic projection? (2) Use freehand sketch, draw a pictorial drawing.	Attempt the questions.
5.	Summary	Review the whole lesson	Listen to the teacher and ask question

CONVENTIONAL LESSON PLAN 7

Subject: Technical Drawing
Topic: Basic Principles of orthographic projection.
Class: T^2 **Age of Students:** 14-16 years
Duration: 1:30mins **Date:**
Specific Objectives: At the end of lesson presentation, the students should be able to:

(1) Draw a pictorial view of an object block
(2) Sketch 1st angle of orthographic drawing from a given pictorial drawing
(3) Relate pictorial view to planes of projection.

Entry Behaviour: Student must have seen a box of sugar.

Instructional Materials: chalkboard and drawing instrument.

Instructional Procedure

Steps	**Content**	**Teacher's Activity**	**Student's Activity**
	Set Induction	**Review the previous lesson**	**Listen to the teacher**
1.	Drawing of pictorial view of a block	Drawing of a pictorial view.	Listen to the teachers. Follow the procedure. draw the view.
2.	Orthographic view in 1^{st}	The teacher draws orthographic view of 1^{st} angle.	The students learn how to draw orthographic views in 1^{st} angle.
3.	Relation of pictorial views to planes of projection.	The teacher explains and sketches how pictorial drawing relates to planes of projection.	The students listen, ask question and practice how to relate pictorial drawing to planes of projection.
4.	Evaluation	Answer the following questions: (1) Sketch pictorial view of any object (2) Draw a view in the 1^{st} angle drawing.	Attempt the questions.
5.	Summary	Review the whole lesson	Listen to the teacher and ask question

CONVENTIONAL LESSON PLAN 8

Subject: Technical Drawing
Topic: Principles of Sectioning
Class: T^2 **Age of Students:** 14 – 16 years
Duration 1.30mins **Date:**
Specific Objectives: At the end of the lesson, the students should be able to:

(1) State the purposes of sectioning
(2) Illustrate with sketches methods of sectioning
(3) Draw full sectioning view of an object

Instructional Materials: Chalk board, Tee square, sets squares and Chalk

Instructional Procedure

Steps	Content	Teacher's Activity	Student's Activity
	Set Induction	Review the previous lesson	Listen to the teacher
1.	Purposes of sectioning	Discuss the purposes of sectioning	Listen to the teacher and take note
2.	Sketches on methods of sectioning	Carry out sectioning in different ways of full and half sectioning	Draw sectioning in different ways and ask questions
3.	Draw full sectioning of an object.	Draw correctly sectioning view of an object.	Learn to draw correct sectioning of an object.
4.	Evaluation	Answer the following questions: (1) State two purposes of sectioning. (2)List different ways of sectioning. (3) Apply sectioning in isometric block.	Attempt the question.
6.	Summary	Recapitulate the whole lesson	Listen to the teacher and ask question

CONVENTIONAL LESSON PLAN 9

Subject: Technical Drawing
Topic: Principles of Dimensioning.
Class: T^2 **Age of Students:** 14-16 years
Duration: 1:30mins **Date:**
Specific Objectives: At the end of lesson presentation, the students should be able to:

(1) Define dimension
(2) State the purpose of dimensioning
(3) Mention with sketches rules of dimension
(4) Distinguish between leader line and extension line
(5) Sketch and explain the principle of dimensioning from datum

Entry Behaviour: The Student must have seen the inside of a box.

Instructional Materials: chalkboard and set squares

Instructional Procedure

Steps	Content		Teacher's Activity	Student's Activity
	Set Induction		**Review the previous lesson**	**Listen to the teacher**
1.	Define dimension		The teacher defines what is dimension	The stud

			ents listen ask question and take note
2.	State the purpose of dimension.	The teacher state the purposes of dimension	The student's

			listen, ask questions and take note.
3.	Rules in dimensioning	The teacher states the rules in dimensioning.	The student ta

			ke note on different rules of dimensioning
4.	Explanation of leader and extension line	Explain with sketches principles of dimensions to students	The stude

			nts take note, ask question and sketch the diagrams

			.
5.	Dimension from a given Datum.	The teacher explains with a sketch of pictorial and Orthographic projection how Datum dimension is made.	The students take note of the dimension position a

			nd make sketches in pictorial and Orthographic proj

			ection.
6.	Evaluation	Answer the following questions: 1. State the purpose of dimensioning 2. Sketches an object and show how the major types of dimension are used 3. State at least 3 types of rules covering dimension	Attempt all questions
.	Summary	Recapitulate the whole lesson	Listen to the teacher

			and ask question

CONVENTIONAL LESSON PLAN 10

Subject: Technical Drawing
Topic: Principle of Auxiliary Projection.
Class: T^2 **Age of Students:** 14-16 years
Duration: 1:30mins **Date:**
Specific Objectives: At the end of lesson presentation, the students should be able to:

(1) Explain the meaning of auxiliary projection
(2) Mention rules regarding auxiliary projection
(3) State advantages of auxiliary projection
(4) Demonstrate with sketches the application of auxiliary projection.

Entry Behaviour: The Student must have seen an incline plane of a wedge.

Instructional Materials: chalkboard and set-squares

Instructional Procedure

Steps	Content	Teacher's Activity	Student's Activity
	Set Induction	Review the previous lesson	Listen to the teacher
1.	Auxiliary projection	Discuss the meaning of auxiliary projection	
2.	Application of auxiliary projection	Demonstrate the application of Auxiliary Projection	Listen to the teacher and ask question.
3.	Concepts of auxiliary planes	Sketches the concept of auxiliary plane	Learn to sketches the concept of auxiliary plane
4.	Factors of auxiliary plane	State the principles factors that determine	Listen to the teacher, take note and ask

		the relative position to normal plane of project.	questions.
5.	Evaluation	Answer the following questions: (1) What is auxiliary projection? (3) Sketch a concept of auxiliary projection. (4) State the factor of delimiting of auxiliary projection	Attempt the question.
6.	Summary	Review the entire lesson	Listen to the teacher and ask question

APPENDIX G
AUTOTEDRACAD LESSON PLAN 1

Subject: Technical Drawing
Topic: Forms of Drawings and their Applications
Class: T^2 **Age of Students:** 14 – 16 years
Duration: 1.30 mins **Date:**
Specific Objectives: At the end of lesson presentation the students should be able to:

(1) Describe drawing as a language of communication
(2) Explain and identify by sketch forms of drawing
(3) Express pictorial drawing as a 3 dimensional view
(4) State advantages of the forms of drawing
(5) Practically express pictorial and orthographic drawing

Entry Behaviour: The students must have seen road sign of two children with a school bag on Zebra Crossing.
The teacher asks the following Question: What does the Zebra crossing signifies? Mention other road signs that easily communicate to people.
Instructional Materials: AUTOTEDRACAD Software, Mouse and keyboard
Instructional Procedure

Step	Content	Student's Activity	AutoTedra Techniqu	Remedial	Acceptable level of performan	Skill Acquired

			e		ce	
1	Drawing as a means of communication	The student browse through content, open to the usage of drawing and learn facts on how drawing is a means of communication	SI MP			Academic Skill
2.	The forms of drawing axonometric, Isometric etc	The students browse to different forms of drawing and identify the sketches.	SI MP PS			Academic/Job place skills
3.	Expression of pictorial drawing as 3 D	Click the content and learn how to express pictorial drawing as 3D	SI MP PS			Academic/Job place skills
4	Advantages of forms of drawing	The student click, open the content to learn advantages of drawing.	SI MP			Academic/Job place skills
5	The Application of forms of drawing in the manufacturing and construction industries	The students browse to option watch, the computer and learn how different forms of drawing are applied in the manufacturing and construction industries	SI MP PS			Academic/Job place skills
6.	Summary	The students recap the whole lesson	Review			
	Evaluation	State at least three reasons why different forms of drawing are used in the manufacturing and construction industries	CBE			

KEY: Sequential Instruction = SI; Multi-Sensory Presentation = MP; Competency Based Evaluation = CBE; Surface Modeling = SM; Problem Solving = PS

AUTOTEDRACAD LESSON PLAN 2

Subject: Technical Drawing
Topic: Application of Lines and Lettering
Class: T^2 **Age of Students**: 14 – 16 years
Duration: 1.30mins **Date:**
Specific Objectives: At the end of lesson presentation the students should be able to

(1) Identify types of lines and state position of usage
(2) Describe lettering and state it application
(3) State importance requirement for lettering
(4) Practical application on lettering

Entry Behaviour: The students must have drawn lines on their exercise book and write words in between lines. Ask these questions: Show by writing two types of Lettering and - Draw vertical and horizontal lines

Instructional Materials: AUTOTEDRACAD Software, Mouse and Keyboard
Instructional Procedure

Step	Content	Student's Activity	AutoTedra Technique	Remedial	Level of Attainment	Skill Acquired
1	Types of lines (cutting plane, section lines, phantom lines, visible lines, Miscellaneous lines, Hidden features, Extension, dimension lines.	The students navigate the cursor open the tutor, identify and learn different types of lines.	SI MP PS			Academic Skill

2.	Types of lettering single, incline, Board pen and stencil lettering	The students click the option mode and open the content on types of lettering. They learn how to write upper and lower case lettering both in vertical and sloping lettering	SI MP PS			Academic skill/Job place skills
3	Requirement for lettering	The student move the cursor to this content and learn lettering requirement	SI MP PS			
4	Application of lines and lettering on drawing	The next option mode is click and the procedure for the application of lines and lettering. The students learn the procedure and apply it in the construction of a circle.	SI MP PS			Academic skill/work place skills
5.	Summary	The students recapitulate the lesson	Review			
	Evaluation	Construct a box and apply the technique of lines and incline lettering on the object.	CBE			

KEY: Sequential Instruction = SI; Multi-Sensory Presentation = MP; Competency Based Evaluation = CBE; Surface Modeling = SM; Problem Solving = PS

AUTOTEDRACAD LESSON PLAN 3

Subject: Technical Drawing
Topic: Symbols and Conventions
Class: T^2 **Age of Students**: 14 – 16 years
Duration: 1.30 mins **Date:**
Specific Objectives: At the end of the lesson, the students should be able to:

(1) Define symbols and conventions
(2) Illustrate with sketches symbols and conventions for engineering materials
(3) Illustrate with sketches symbols and convention for building materials
(4) Illustrate with sketches symbols and convention for electrical materials
(5) Draw orthographic projection of nuts.

Entry Behaviour: The students must have seen various shapes like ball, funnel and tin milk.
The teacher asks question, Draw a balloon, sketch a fridge, and a packet of sugar.

Instructional Materials: AUTOTEDRACAD Software, Mouse and Keyboard
Instructional Procedure

Step	Content	Student's Activity	AutoTedra Technique	Remedial	Acceptable Level of performance	Skill Acquired
1	Define symbols and conventions	The students open the software and learn symbols and conventions.	SI MP			Academic Skill
2	Sketches on symbols and conventions in engineering	The students navigate the cursor to menu option open and learn how to sketches Engineering materials.	SI MP			Academic Skill
3.	Sketches on symbols and conventions in building	The students navigate the cursor to menu option	SI MP PS			Academic skill/work place skills

		open and learn how to sketches building materials.				
4.	Sketches on symbols and conventions in electrical	illustrate with sketches at least three symbols used in Electrical	SI MP PS			Academic skills
5.	Orthographic view of nut	The students browse to contents click to menu option, Read the instruction and draw nut.	SI, MP PS			Academic/ Work place skill
	Summary	Review the whole lesson				
	Evaluation	Draw the shape of a nut.	CBE			

KEY: Sequential Instruction = SI; Multi-Sensory Presentation = MP; Competency Based Evaluation = CBE; Surface Modeling = SM; Problem Solving = PS

AUTOTEDRACAD LESSON PLAN 4

Subject: Technical Drawing
Topic: Intersection and Development
Class: T^2 **Age of Students**: 14 – 16 years
Duration: 1.30 mins **Date:**
Specific Objectives: At the end of the lesson, the students should be able to:

(1) Determine lines of intersection of the meeting surfaces
(2) Describe methods of development
(3) Practical application of developing simple surface

Entry Behaviour: The students were taught various shapes and plane figures in the last lesson. The teacher asks question. What is the difference between a plane figure and solid figure?

Instructional Materials: AUTOTEDRACAD Software, Mouse and Keyboard

Instructional Procedure

Step	Content	Student's Activity	AutoTedra Technique	Remedial	Level of Attainment	Skill Acquired
1	Intersection of meeting surface	The student browse to content, listen to the procedure that determines lines of intersection	SI MP PS			Academic/Work Place Skill
2.	The students click the menu option and learn to draw at least three methods of development.	The students click to content and learn methods of development	SI MP PS			Academic/work place skills
3.	Development of simple surface		SI MP PS			Academic/Work place skills
	Summary	Review the whole lesson.				
	Evaluation	Using Radial	CBE			

		lines develop a simple surface of the object of 80mmx 35mm				

KEY: Sequential Instruction = SI; Multi-Sensory Presentation = MP; Competency Based Evaluation = CBE; Surface Modeling = SM; Problem Solving = PS

AUTOTEDRACAD LESSON PLAN 5

Subject: Technical Drawing
Topic: Principles of Loci
Class: T^2 **Age of Students**: 14 – 16 years
Duration: 1.30mins **Date:**
Specific Objectives: At the end of the lesson, the students should be able to:

(1) Define terms associated with circles
(2) Construct and read plane scale
(3) Construct Geometrical tangency

Entry Behaviour: The students have made full stop on their notes. The teacher asks this question. What is the shape of full stop on your note?

Instructional Materials: AUTOTEDRACAD Software, Mouse and Keyboard
Instructional Procedure

Step	Content	Student's Activity	AutoTedra Technique	Remedial	Acceptable level of performance	Skill Acquired
1	Definition of tangent, circles and terms associated with circle	The student navigates to the content, listen to the terms, learn the terms and draw the circle. .	SI MP PS			Academic/ Work Place Skill
2.	Construction and reading of plane scale	The students click to the content and learn the construction and reading of plane scale.	SI MP PS			Academic/ Work place skills

3.	Construction of tangency	The students click to content learn how to construct tangency of two circle revolving on each other.	SI, MSP PS			Academic/ Work place skill
	Summary	Recapitulate the whole lesson				
	Evaluation	With a given data construct a tangency of two unequalled circle sliding over each other	CBE			

KEY: Sequential Instruction = SI; Multi-Sensory Presentation = MP; Competency Based Evaluation = CBE; Surface Modeling = SM; Problem Solving = PS

AUTOTEDRACAD LESSON PLAN 6

Subject: Technical Drawing
Topic: Principles of Orthographic Projection
Class: T^2 **Age of Students**: 14 – 16 years
Duration: 1.30mins **Date:**
Specific Objectives: At the end of the lesson presentation, the students should be able to:

(1) Define orthographic projection
(2) Describe the concepts of 1st & 3rd angle projection
(3) Identify the principal planes of projection
(4) Draw the missing view from an orthographic

Entry Behaviour: The students are familiar with a cement block and vee block in their workshops
The teacher asks questions, Draw out a sugar packet show its faces one after the other

Instructional Materials: AUTOTEDRACAD Software, Mouse and Keyboard
Instructional Procedure

Step	Content	Student's Activity	AutoTedra Technique	Remedial	Level of Attainment	Skill Acquired
1.	Define orthographic projection	The computer defines orthographic project	SI MP			Academic Skill.
2.	Demonstration of 1st & 3rd angles of projection	The students click to content watch carefully how the computer model the concept of 1st & 3rd angle of projection	SI MP PS			Academic skill/work place skills

3.	Principal plane of projection	The students navigate to content, watch carefully to note the procedure on how to model an object in a plane of projection.	SI, MP SM PM			Academic/ Work place skills
3.	Draw the missing view	Browse to content and draw the missing view from the given orthographic view.	SI, MP SM PS			Academic/ Work place skills
4.	Summary	The Students recap the whole lesson				
	Evaluation	Picking the right tool sketch neatly the missing part of orthographic view.	CBE			

KEY: Sequential Instruction = SI; Multi-Sensory Presentation = MP; Competency Based Evaluation = CBE; Surface Modeling = SM; Problem Solving = PS

AUTOTEDRACAD LESSON PLAN 7

Subject: Technical Drawing
Topic: Basic Principles of Orthographic Projection
Class: T^2 **Age of Students**: 14 – 16 years
Duration: 1.30 mins **Date:**
Specific Objectives: At the end of the lesson presentation, the students should be able to:

(1) Draw a pictorial view of an object block
(2) Sketch 1st angle of orthographic drawing from a given pictorial drawing
(3) Relate pictorial view to planes of projection

Entry Behaviour: The students were taught how to draw a packet of sugar. The teacher asks this question, Draw to the shape of a sugar packet the side seeing on your left direction.

Instructional Materials: AUTOTEDRACAD Software, Mouse and Keyboard
Instructional Procedure

Step	Content	Student's Activity	AutoTedra Technique	Remedial	Level of Attainment	Skill Acquired
1.	Draw the pictorial view of an object.	The students is presented with a view of a block.	SI MP SM			Academic/ Work place skills
2.	Sketches of Orthographic views	The students click to content and carefully watch the procedure and sketch orthographic view of the object shown.	SI MP SM PS			Academic/ Work place skills

3.	Relationship of Pictorial view to planes of projection	The students click to content, watch carefully, and study how to relate pictorial view to planes of projection from a given data	SI MP SM PS			Academic/ Work place skills
	Summary	The Students recap the whole lesson				
	Evaluation	Demonstrat e with a sketch relationship between planes of projection.	CBE			

KEY: Sequential Instruction = SI; Multi-Sensory Presentation = MP; Competency Based Evaluation = CBE; Surface Modeling = SM; Problem Solving = PS

AUTOTEDRACAD LESSON PLAN 8

Subject: Technical Drawing
Topic: Principles of Sectioning
Class: T^2 **Age of Students** 14 – 16 years
Duration: 1.30 mins **Date:**
Specific Objectives: At the end of the lesson presentation, the students should be able to:

(1) State the purposes of sectioning
(2) Illustrate with sketches method of sectioning
(3) Model full sectioning view of an object

Entry Behaviour: The students must have known that a pipe has a hole inside.
The teacher asks this question. What could be done to enhance understanding of the pipe designers?

Instructional Materials: AUTOTEDRACAD Software, Mouse and Keyboard

Instructional Procedure

Step	Content	Student's Activity	AutoTedra Technique	Remedial	Level of Attainment	Skill Acquired
1	Purpose of sectioning	The students click on the content and learn purposes of sectioning	SI MP			Academic Skill
2.	Methods of sectioning full size, removal, offset.	The students click on content, listen carefully and sketch methods of sectioning.	SI MP PS			Academic skill/work place skills

3.	Section Orthographic projection	The students navigate to content. carefully learn the correct method of sectioning a views	SI MP SM			Academic/Work place skills
	Evaluation	From a given Orthographic view draw full sectioning	CBE			

KEY: Sequential Instruction = SI; Multi-Sensory Presentation = MP; Competency Based Evaluation = CBE; Surface Modeling = SM; Problem Solving = PS

AUTOTEDRACAD LESSON PLAN 9

Subject: Technical Drawing
Topic: Principles of Dimensions
Class: T^2 **Age of Students** 14 – 16 years
Duration: 1.30 mins **Date**:
Specific Objectives: At the end of the lesson presentation, the students should be able to:

(1) Define dimension
(2) State the purpose of dimensioning
(3) Mention with sketches rules of dimension
(4) Distinguish between leader line and extension line
(5) Sketch and explain the principle of dimensioning from datum

Instructional Materials: AUTOTEDRACAD Software, Mouse and Keyboard

Instructional Procedure

Step	Content	Student's Activity	AutoTedra Technique	Remedial	Level of Attainment	Skill Acquired
1	Define Dimension	The student click to content and study the definition of dimension	SI MP PS			Academic Skill

2	Purposes and rules of dimensioning	The students click to option, listen carefully and learn the purposes of dimensioning	SI MP			Academic Skill
3	Explanation with sketches General rule of dimension	The students click to option and learn to distinguish types of lines when in use	SI MP PS			Academic /job skill
4.	Leader and Extension lines	The students click to content and study the distinction between leader and extension lines.	SI MP PS			Academic skills
5.	Purposes and principles of Dimension from Datum	The students navigate the cursor to content and learn the principles of dimensioning from datum	SI, MP PS			Academic/ Work place skills
	Summary	Recapitulation of the whole lesson	Review			
	Evaluation	Illustrate with a sketch the principles of	CBE			

		datum				

KEY: Sequential Instruction = SI; Multi-Sensory Presentation = MP; Competency Based Evaluation = CBE; Surface Modeling = SM; Problem Solving = PS

AUTOTEDRACAD LESSON PLAN 10

Subject: Technical Drawing
Topic: Principles of Auxiliary Projection
Class: T^2 **Age of Students:** 14 – 16 years
Duration: 1.30 mins **Date:**
Specific Objectives: At the end of the lesson, the students should be able to:

(1) Explain the meaning of auxiliary projection
(2) Mention rules regarding auxiliary projection
(3) State advantages of auxiliary projection

(4 Demonstrate with sketches the application of Auxiliary projection.

Entry Behaviour: The students must have seen objects in a incline plane
The teacher asks questions, gwhen an object is place in relation to vertical and horizontal plane what does the object in the space indicates?

Instructional Materials: AUTOTEDRACAD Software, Mouse and keyboard

Instructional Procedure

Step	Content	Student's Activity	AutoTedra Technique	Remedial	Level of Attainment	Skill Acquired
1	Meaning of Auxiliary	The students click the option, listen carefully and study the meaning of auxiliary projection	SI MP PS			Academic Skill
2.	Rules regarding Auxiliary Projection	The students click to the content and learn the rules covering auxiliary projection	SI MP PS			Academic skill
3.	Advantages of auxiliary projection	The students navigate to the content and learn the advantages of auxiliary projection	SI MP			Academic / Work place skills

4.	Application of auxiliary projection	The students click the mouse, listen carefully and learn the	SI, MP			Academic skill
	Summary	The student review the whole lesson				
	Evaluation	Construct first auxiliary plan from a given principal view	CBE			

KEY: Sequential Instruction = SI; Multi-Sensory Presentation = MP; Competency Evaluation = CBE; Problem Solving = PS; Surface Modeling = SM

APPENDIX H

LETTER OF INTRODUCTION

Department of Vocational Education
University of Nigeria
Nsukka
15th February, 2008

Dear Research Assistant,

I am a postgraduate student of the above named institution conducting research to determine the effects of Automated Technical Drawing Computer Assisted Drafting (AUTOTEDRACAD) Technique on Students' Academic Achievement and Retention in Technical Drawing. The Finding of the study will be useful to the Students, Technical Teachers, Curriculum experts, Official of the State Technical Education, as the derogatory traditional method would be replaced by a more interactive approach to instruction in Technical Drawing.

Your kind assistance is therefore solicited. The research is strictly for academic purpose. Any information supply for the study will be treated confidently.

Usoro, Aniedi Daniel	**Dr. B. A. Ogow**	**Dr. (Mrs) T .C.Ogbuanya**
(Researcher)	Supervisor	Supervisor

APPENDIX I

Department of Vocational Education
University of Nigeria
Nsukka

15th February, 2008

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Dear Sir,

Request for Validation of Research Instrument

I am a postgraduate student in the department of Vocational Education (Industrial Technical Education Section) University of Nigeria, Nsukka. Currently undertaking a Research thesis aimed at determining the effects of Automated Technical Drawing Computer Assisted Drafting (AUTOTEDRACAD) Technique on Students' Academic Achievement and Retention in Technical Drawing.

Enclosed here is a draft of the Instrument; you are requested to read through the items and vet their clarity and relevance to the topic in question. Sir, I also request that you could put down your comments and suggestion.

Thanks
Yours Faithfully,

Usoro, Aniedi Daniel