ISSN No:-2456-2165

Development of Computer Aided Software (CAS) For Learning Matrices at Senior Secondary School Level in Bauchi Metropolis, Bauchi State, Nigeria

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Abstract:- This research study was on the development of Computer Aided Software application package for teaching and learning matrices at senior secondary school level. The application package was designed using visual Basic, Version 6.0. Two research questions and two hypotheses were formulated and tested at 0.05 level of significance respectively. The research design that was adopted was pretest – posttest experimental research design, which was carried out in two privately owned secondary schools in Bauchi metropolis. Sixty (60) students of senior secondary schools were randomly selected and used as subjects in the study which were grouped into two, the control and experimental group respectively. The experimental group was taught with CAS package while the control group was taught using traditional teaching method. The instrument ADT was used for the collection of the data. Mean, standard deviation and t-test were used in the analysis of the data, answer the research questions and test the hypotheses in the study. The finding of the study shows that, there is significance difference in the mean performance of students taught matrices with CAS package over those taught with traditional teaching method and there is significant difference in the mean performance of Pretest and Posttest students taught matrix with CAS package. There is also significant difference between the protest and posttest mean performance of students taught matrix using traditional teaching method. Thus, it is recommended from the findings of this study that the teachers should employ the use of computer assisted instructions in teaching matrices and other aspects of mathematics in senior secondary school, since its usage enhances students' conceptual understanding in matrices.

Keywords:- *Computer Aided Software (CAS), Learning, Matrices, Secondary School.*

I. INTRODUCTION

Mathematics has been universally accepted as the core subject for the science, it's pre-requisite for many careers and in a society that is increasing technologically today. Thus, operation and career progress of individuals and it thus occupies a well-established position in the school curriculum, it plays a very important role that state and Federal Government of Nigeria made it compulsory at O-levels for admission into any higher institutions Adetunji(2001), asserted that the rate at which student fail mathematics cannot be over emphasize. Whereas Ale, (1989), the analysis at 2008 mathematics on the poor West Africa Examination Council (WAEC) result has shown that only 13% of the student that sat for the examination pass with credit in mathematics Uwadiae, (2008). The continue poor performance of subjects, generally in science and particularly in mathematics over the years has been of great concern researchers, classroom teachers, parents and educational policy makers in Nigeria. Adeniyi, (1988), attempted to find out factors that could be responsible for the poor performance in mathematics and instructional technique employed by the teachers as the major causes of poor performance among secondary school students in mathematics.

However, the problem of poor performance of students in mathematic can be minimize to a large extend if teachers are well expose to difference types of instructional learning techniques e.g problem solving strategy, which enhance the effectiveness in evaluating students learning outcome at the end of activity-based learning stability of the learner. Mathematics is an indispensable medium by which science expresses, formulate and communicate it. Thus, it is regarded as the basis of the greater part of the civilization today, which served in the development human intelligent in a greater variety of ways. In mathematics, a matrix or matrices is a rectangular array of number, symbols or expression. Therefore, the concept of matrices is applicable in both pure and applied sciences. Individual items in a matrix are called elements or entries. Matrices find applications in most scientific fields. In physics, matrices are used to study electrical circuits, optics and quantum mechanics. In computer graphics, matrices are used to project a 3-dimentional images into a 2-dimentional severe, and to create realistic seeming motion.

There are a number of operations that can be perform or applied to modify matrices called matrix addition, scalar multiplication, transposition, determinants, inverse etc. One of the main benefit of matrices is the properties which allow them to be manipulated and used for many different, but useful purposes. Matrices can varies in size. This vibration in size is called dimension, just like the dimensions of a room (width x length), matrices have dimension (number of row x number of columns). Thus, a 3 x 3 (real 3 by 3) matrix

ISSN No:-2456-2165

will have 3 rows and 3 columns. Another term associated with matrix is address which is like your home address, an address describes where each value or entry of a matrix lives. The address is composed of the lower cast letter of the matrix. This row and column number (in that order) as subscripts.

The remainder of this paper is structured as follows. section two presents related works using computer aided software for learning matrices. Implementation methodology and dataset used is presented in section three. Section four presentations of result. Discussion of findings are presented in section five. Conclusion and recommendation are presented in Section six.

➢ *Statement of the Problem*

Ali, (1983), mathematics as a subject has been associated with a lot of problems both in the teaching and learning. For example, most teachers are not able to put across the mathematics concepts to the students there by making the subject difficult to understand. It has been recorded that low achievement and poor performance in national and international examination.

Mathematics as a subject has a basic concept which has to be well delivered to students so as to achieve the objective of the subject at all levels of education. Also, students' poor interest in mathematics is another problem, because what student is not interested in, they will not understand nor have a desire to learn. Thus, this result in find out more effective way that will enhance students' performance and conceptual understanding in mathematics, particularly the concept of matrices. In line with this therefore, the problem of this study is development and validation of Computer Aided Software (CAS) for learning matrix in senior secondary schools.

The aim of this research paper is development of software (CAS) for teaching and learning matrices at secondary school level and to test and validate the effectiveness of the Computer Aided Instruction (CAS) in learning the concept of matrices in secondary school.

Specifically, this paper addresses the following research questions in three areas, by means of a systematic review (see Gough, Oliver, & Thomas, 2017)**.**

i) What are the procedures involved in the development of a Computer Aided Software for learning matrices in senior secondary school mathematics?
ii) To what extend does the use of (CAS) enhance student performance in concept of matrices in senior secondary school mathematics?

➢ *Hypothesis*

i. There is no significant difference between the pre-test and post-test mean performance of student matrices taught using software development.
ii. There is no significant difference between academic performance of learners taught matrices using software and those taught using traditional method

II. LITERATURE REVIEW

In order to achieve the Millennium Development Goals (MDGs), teaching and learning should be geared towards using appropriate technology to meet up with students' mathematical needs and prepare themto solve societal problem. The technology that is being referred to here is the computer. Computer technology is an innovation in mathematics teaching and learning. According to Michael (2002), the use of computer in teaching and learning mathematics is gradually being embraced by many people as people no longer ask whether computer should be use in teaching,and how it should be use.

Usman (2002) equally indicatedthat the computer could be used in three modes: as a tutor, tool and tutee. Using computer as a tutor refer to a situation where the computer performs a teaching role. This application is often referred to a Computer Based Instruction (CBI), Computer Assisted Instruction (CAI) as follows: presentation of information, students, response, and evaluation of the student's response by the computer and determination of what to do next. According to Landaure, (1995) in using computer as a tutor, the computer replaces human in performance of a task. It involves CAI where the programmed instruction presents content which posses questions, request for students responses, analyses the responses, supplies appropriate feedback and practice until learners demonstrate a pre-determined level of understanding and competency. Apart from using computer as a tutor, computer could also be used as a tool. According to Timothy *etal.,* (2006), computer as a tool refers to using computer as a productivity tool for common talks. This involves word processing, graphic packages, presentation software, data base and spread sheet.

Means (1994) noted that computer could be used as an exploratory tool informs of CD-ROM, encyclopedia, laboratory in solving mathematical problems especially in Algebra, statistic and geometry, computer could be used for learning problems solving methods Chris (2001),is of view that computer is a sophisticated toolin performing tasks that should argument human performing. This study is using computer as a tool which will help the teacher as instructional material, where the teacher after teaching, uses the computerized matrices application software to demonstrate it computational powers. Using computer as tutor and tool exposes students to credulity and developing problem solving skill in order to meet up with demands of the MDGs, to attain the millennium goals, education should shift from teacher. Centered types of education to learner centered and activity-oriented type of education student need to find out thing by themselves in which case technology is employed. Timothy *et al.*,(2006) highlighted the importance of technology as the systematic application of scientific and other organized knowledge to practical task. It is equally the manner in which researcher is applied to solve practical problems. In the learner centered type of education, the students instead of passively waiting for the teacher to give direction and information is actively searching for the needed information and learning

experiences, determine what is needed and seeking for ways of attaining them. With the use of the computer students will desire, explore, discover and create unique solution to learning problem. Teacher on their own part are viewed as supporters, collaborators, and coach for students as they learn together and evaluate information for themselves.

However, to meet up with the challenges of the MDG's computer application should be brought to this knowledge of both teacher and students. It is in this regard that this study is carried out the use of computer as tool and tutor in teaching and learning of matrices so as to determine the mode that will be at secondary school level.

➢ *Theoretical Framework*

The theories of learning are as a result of long year of study and research by a number of scholars. It consists of a set of assumptions from which endless hypothesis may be draw for testing. A theory of learning can be used as a curriculum guided for design of curriculum, curriculum activities of both teachers and learners in the classrooms and outside the classrooms.A teacher needs profound theoretical understanding of learning process in order to carry out these responsibilities respectively Koladele (1998).Theories of learning which have the greatest and most direct implication in classroom teaching can be grouped under two headings namely: Association and Cognitive theories. Associative theories were further classified to stimulus response (S-R) with reinforcement which was credited to Edward Thorndike, B.F Skinner and Clark L. Hull. The other class is credited to P. Payola. John B. Waston and Cognitive theory of E.R Guthrie. The Cognitive theory of learning was also classified into gestalt theory of learning by W.E. Kohler and other gestalt theory of learning of Talma Koladele (1998).

Edward Thorndike (1874-1949) in the United State of America investigated learning in animal by using cats. A hungry cat was confined in puzzle box with food visible to her outside the box. The cat had escape to get food through a release mechanism. Thorndike in his study concluded that animals learn throng active behaviors, accident and through chance to succeed. Thorndike experiment of problem approach, as a description of learning process, and pioneering efforts that established learning with motivation, reception and reward Encyclopedia Americana international 1989). B.F Skinner theory of learning B.F skinner, an America psychology born in 1904, suggested that learning is a series of experiences each of which influences behavior in the same way that conditioning responses are learned or acquired. Skinner box. The box contains a lever that releases a peeled of food into a tray and at the same time automatically register the response on a time chart. A hungry rat is kept in the box and the rat press the bar and a pellet of food fall into the dish the food reinforces the bar pressing (responses). Skinner and other learning theories continued earlier work of Sydney L. mechanism. These have manifested into the present-day Computer Assisted Instruction (CAI) with development in communication technology (Encyclopedia America International 1989).

➢ *The Use of CAS in Education*

CAI can dramatically increase a student's access to information. The program can adapt to the preference of the individual students and increases the amount of per signalized instruction a student receives. Many students benefit from the immediate responsiveness of computer interrelations and appreciate the self- paced ad private learning environment. More, computer learning experience often engages the interest of students motivating them to learn, increase independence and personal responsibility for education. Software companies provide educational support services at reasonable costs and are putting various packages in place. These include on optical mark is also capable of taking candidates in multiple choice tests. Computers in the classroom will introduce grate change in education, for under proper supervision, it can be used to entrance the educational process and equip each learner with an exciting medium for problem solving. The use of visual display units to deliver lectures will promote individualized of manipulation skill early in life will one a direct advantage to children who frequent experimental classrooms to command a computer to draw pictures, play music or to articulate and provide explanation for their latest program. Hence, the need for children to be aware of the nature and uses of computer in order to be able to cope with the present and improving the learning process by the introduction of computers. Walker (1984), sees CAI as having on egged over other teaching methods in view of its uniqueness such as speed, reliability, equipment continuation of page 10 to other methods of teaching have been conducted since 1980s.

Revered and Rich (1985) compare the effects of (CAI) and traditional instruction on the mathematics achievement and attitudes of disadvantage Israeli students in grade 3,4, and 5. The request indicated that students in the CAI group scored tighter on achievement. In addition, their attitudes toward school themselves as mathematics learners were more positive.

➢ *The Concept of Matrices*

The history of matrices goes back to ancient times. But the term "matrix" was not applied to the concept until 1850. Matrix is the Latin word for womb, and it retains that sense in English. It can also mean more generally any place in which something is formed or produced.

The origins of mathematical matrices liaise with the study of system of simultaneous linear equations. An important Chinese text between 300BC and 200AD, Nine chapters of their mathematical Art (Chiu Chang Suan Shu), gives the first known example of the use of matrix methods to solve simultaneous equations. In the treatise's seventh chapter; "Too much and not enough", the concept of a determinant first appears, nearly two millennium before its supposed invention by the Japanese mathematician Seki Kowa in 1683. More use of matrix-like arrangements of numbers appear in chapter eight, "method of rectangular arrays", in which a method is given for solving simultaneous equations using a counting board that is mathematically identified to the modern matrix method of solution outlined

by Carl Friedrich Gauss (1777- 1855), also known as Gaussian elimination.

➢ *Definition of Matrices.*

A matrix or matrices is a rectangular array of numbers, symbols, or expression arranged in rows and columns (Beauregard, 1973). The individual items in a matrix are called it elements or entries. Matrices find application in most scientific fields.

➢ *Application of Matrices*

Since first appearance in ancient China, matrices have remained important mathematical tools. Today, they are used not simply for solving system of simultaneous linear equations, but also for describing the quantum mechanics of atomic structure, designing computer game graphics, analyzing relationships, and even plotting complicated dance steps.

There are numerous applications of matrices both in mathematics and other sciences. Some of them merely take advantage of the compact representation of a set of numbers in a matrix. For example, in game theory and economics, the payoff matrix encodes the payoff for two players, depending on which out of a given (finite) set of alternatives the players choose. Early encryption techniques such as the Hill cipher also used matrices.

➢ *Summary of the Literature Reviewed*

Computer Assisted Instruction programs are being used in variety of ways across disciplines in elementary school, secondary and higher education strides in the use of technology in teaching of CAS has proved to be effective Hayes & Robinson, (1999); Waltz, (1994). CAS is an approach to complement and supplement traditional teaching methods. It is not intended to supplement or replace teachers and instructors but to serve as a tool to actively engaged and stimulate students by enhancing the learning process, Hayes & Robison (1999).

III. MATERIALS AND METHODS

➢ *Area of the Study*

The area of the study carried out in Bauchi Metropolis, where only few selected secondary schools offering further mathematics, were used.

➢ *Population of the Study*

The population of the study comprised of all ssII students offering further mathematics in two private secondary schools in Bauchi metropolis.

➢ *Design*

The design used in this research is the experimental design using pre-test – post-test – control group design. This is a true experimental design that controls most of the threats to internal validity of an experimental such as: maturation, instrumentation, selection bias e.t.c. The design required two (2) groups selected at random that is the participants assigned to the groups at random. Having the control group with no treatment and the experiment group taught using CAS as the treatment given. The experiment group was pre-test first, they were taught matrices using CAI package and the control group were given a pre-test and taught matrices using traditional teaching method, after the instructions, a matrices diagnostic test was administered to the experimental and the control groups.

➢ *Sample and Sampling Technique*

The sample for the studies were comprises of students in SS II at random. Certain numbers of students were assigned for the experimental group and also for the control group.

Table 1: sampled of ssII Students used for the Study

Schools	Male	Female	Total
International secondary school A T B U Bauchi	17	13	**30**
Immaculate conception secondary school Bauchi	20	10	**30**

➢ *Instrument*

The research instrument used in this research is a mathematics achievement test which consist of multiple choice having four (4) options from (A-D) for each item with one (1) correct answer and it start from meaning of matrix, matrix notation, addition, subtraction and multiplication of matrices, determinants and inverse of matrices has been covered in developed CAS learning package.

➢ *Validity of the Instrument*

The research instrument developed is a face and content validated by mathematics educationist and educators. They examined the research instrument for suitability and appropriations considering the following:

1. The extent to which instrument test what is expected of the test.
2. Check error in the package and the instrument, and offer suggestions.
3. Check clarity of the test item.
4. Check the appropriation for the instructions and time allocation for the achievement test.

After the validation exercise, all observations and suggestions were noted and corrected before preparing the final draft of the instrument that was used in this study.

➢ *Data Collection*

The researcher used test for the collection of the data with the help of the teachers in the selected schools. The teachers werealso assisted in the delivering of the lesson to both experimental and control groups, the computer teachers werealso participated in teaching the experimental group after being shown how to use the software (CAS).

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At the end of the lessons, achievement test was administered to both the two sampled groups of the two groups that is the experimental and the control groups by the computer teacher.

➢ *Data Analysis*

The data collected was analyzed using the mean, standard deviation to answer the research question. A t- test was also employed to test the hypotheses at 0.05 level of significance.

IV. RESULTS AND DISCUSSION

The procedures in developing the software package for learning Matrices and how to run the program successfully. It also presents the analysis and discussion of the results based on the research questions and hypothesis stated in chapter one.

1 **Research Question One:** What are the procedures involved in the development of a computer Aided software for learning matrices in senior secondary school mathematics.

➢ *The Software Package (CAS) Development Procedures:*

The develop of the package was done by the use of a window base application programming language called visual basic, an event driven and objects-oriented programming language.

The programming was done in three stages:

1. Creating the interface
2. Setting the properties of forms controls
3. Writing a code that controls the process.

Creating the interface means creating the graphical user interface (GUI) or designing how users program should look like. While setting properties of terms and controls involve the setting of different figures of the forms and controls such as name, caption size color, etc. the coding stage is that which controls the way the visual appearance and function of the application should be.

It is the actions of the user on the program that determine functions calls, and perform the required job. The software developed is purposely designed to teach matrices. The main resource material used in the work was Further Mathematics project 3 for senior secondary school and the New General Mathematics for senior secondary schools.

Program Flowchart:

The flowchart refers to the diagrammatical step by step method of solving a problem. It is a chat that shows a flow of data between one stages of the program to another. Below is the main program flowchart.

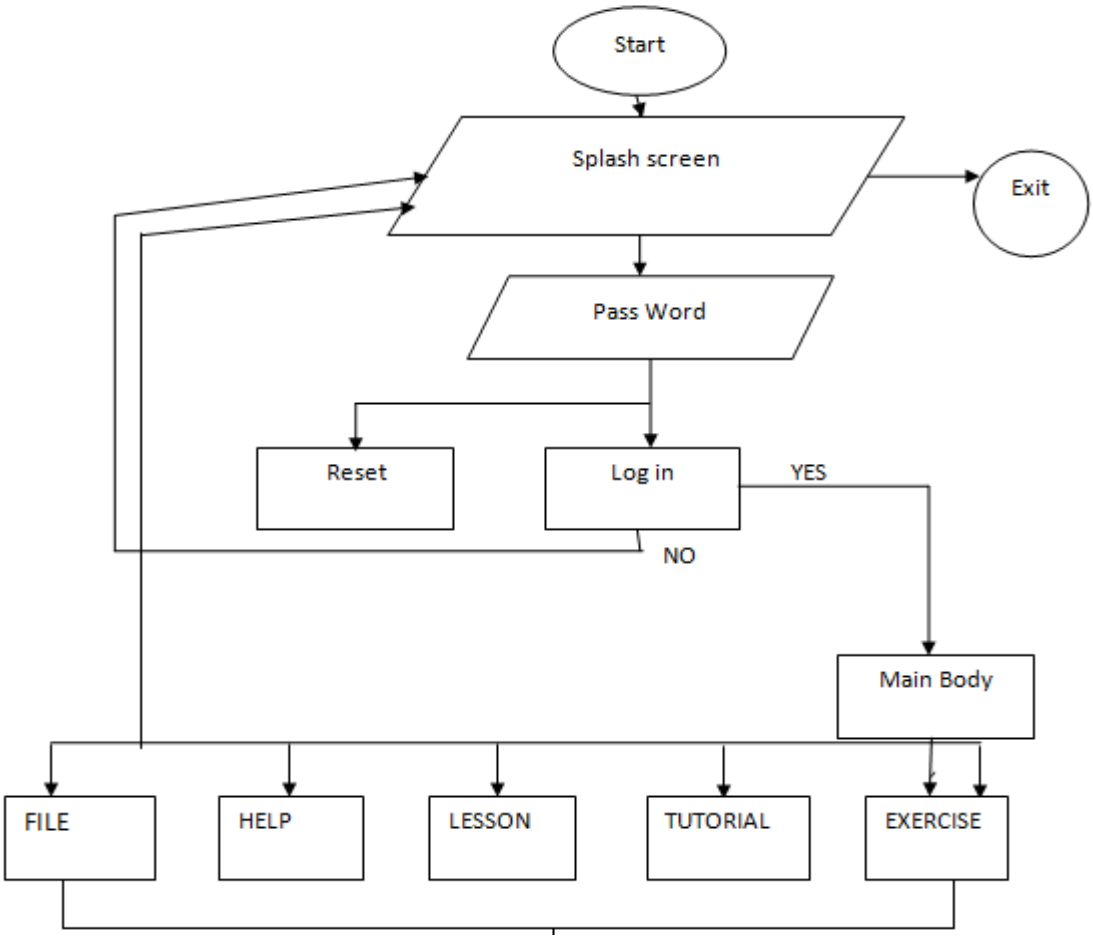


Figure 1

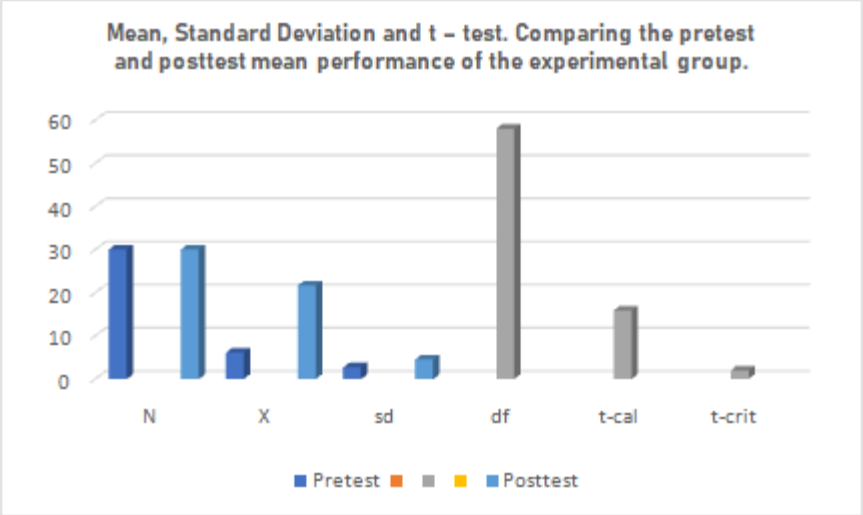
ISSN No:-2456-2165

Hypothesis One: There is no significant difference between the pretest and posttest mean achievement of students taught matrix using software development.

Table 1: Mean, Standard Deviation and t – test. Comparing the pretest and posttest mean performance of the experimental group.

Test	N	$\bar{X}$	sd	df	t-cal	t-crit
Pretest	30	6.10	2.70			
58	15.88	2.00				
Posttest	30	21.704.50				

The results of the pretest and posttest mean performance of students taught matrices shows that the students scored 6.10 and 21.70 respectively. The mean performance difference is 15.6 which shows that there is a significant difference between the pretest and posttest mean achievement of the students. The t-calculated 15.88is greater than the t-critical of 2.00 showing that the hypothesis is rejected.



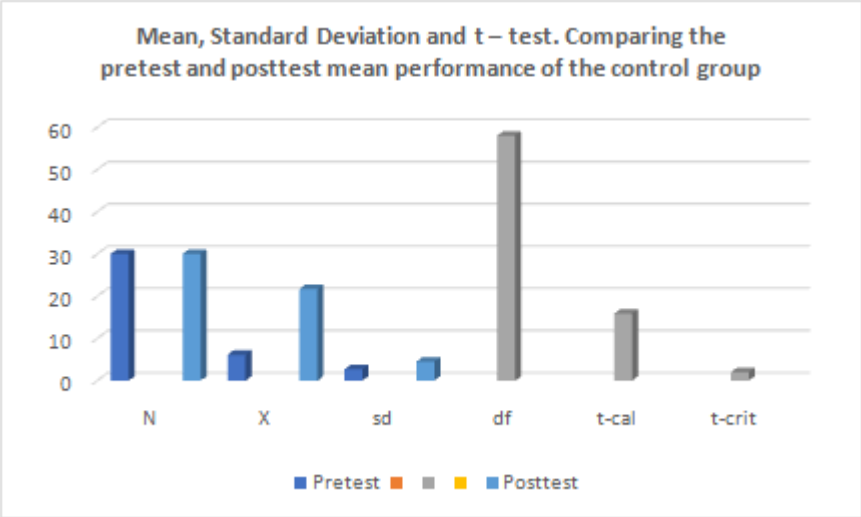
H_{a1}: There is significant difference between the pretest and posttest mean performance of students taught matrices using CAS (Experimental group).

Table 2: Mean, Standard Deviation and t – test. Comparing the pretest and posttest mean performance of the control group.

Test	N	$\bar{X}$	sd	df	t-cal	t-crit
Pretest	30	6.20	2.83			
	58	5.18	2.00			
Posttest	30	10.6	3.59			

ISSN No:-2456-2165

The results of the pretest and posttest mean performance of students taught matrices shows that the students scored 6.20 and 10.6 respectively. The mean performance difference is 4.4 which shows that there is a significant difference between the pretest and posttest mean achievement of the students. The t-calculated 5.18is greater than the t-critical of 2.00 showing that the hypothesis is rejected.



H_{a1}: There is significant difference between the pretest and posttest mean performance of students taught matrices using traditional teaching method.

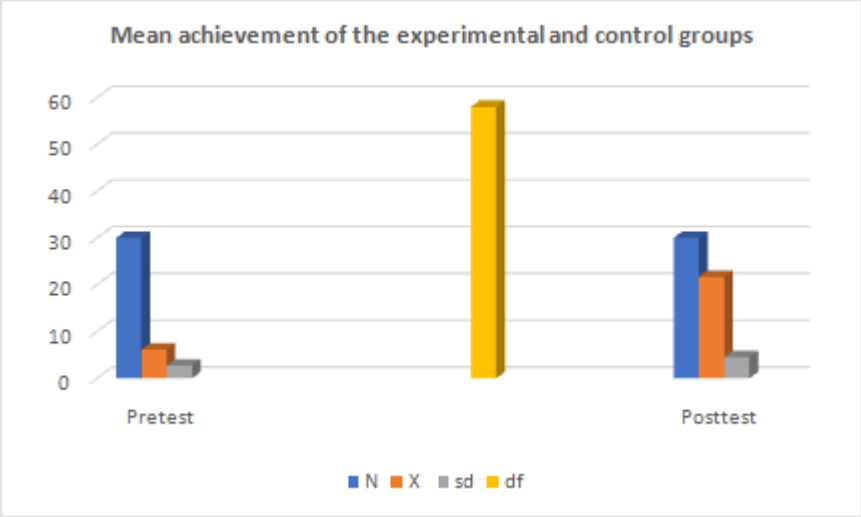
4.2.3 Research Question Two: To what extent does the use of (CAS) enhances students' performance in learning the concept of matrices in secondary school mathematics?

4.2.4 Hypothesis Two: There is no significant difference between students that were taught matrices by the CAS package and those taught matrices without the package.

Table 3: Mean achievement of the experimental and control groups

Group	N	$\bar{X}$ Pretest	$\bar{X}$ Posttest	$\bar{X}$ Gained
Experimental (E)	30	6.20	21.70	27.9
Control (C)	30	6.10	10.6	16.7
Mean Difference	-	0.1	11.1	11.0

From Table 3, it can be seen that in the pretest, the mean performance of the experimental group was 6.20 and the mean performance of the control group is 6.10 with a mean difference of 0.10. Therefore, it can be deduced from the pretest result that the experimental group performed better than the control group. However, in the posttest, the mean performance of the experimental group is 21.7 and the control group was 10.6 with a mean difference of 11.1. The mean gain of the experimental group on both tests was 27.9 and that of the control group was 16.7 with a mean difference of 11.0. It can therefore be deduced from the results that the experimental group which was exposed to the computer application software package performed better than the control group.



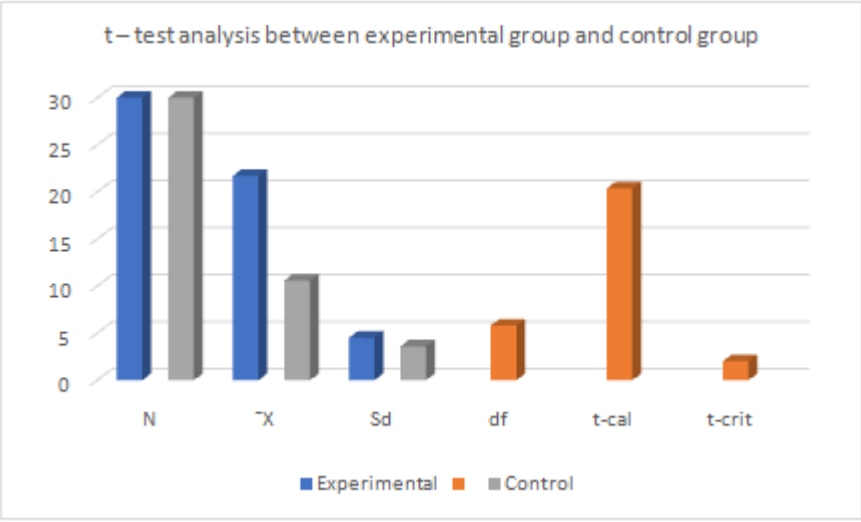
Therefore;

H_{a1}: There is significant difference between the pretest and posttest mean performance of students taught matrices using CAS.

Table 4: t – test analysis between experimental group and control group

Test	N	$\overline{X}$	Sd	df	t-cal	t-crit
Experimental	30	21.70	4.50	58	20.38	2.00
Control	30	10.60	3.59			

In Table 4, t- Calculated value 20.38 is greater than critical value 2.00. Therefore, this shows that there is a significant difference between the mean performances of the two groups in the posttest. Results in table 4 clearly show that the CAS was very effective in learning matrices. Both table 3 and 4 also answer research question two, as there is a significant difference in the effect of CAS on students who learnt Matrices by using the CAS and those who learnt by TTM. Therefore, the Null hypothesis H_{02} was rejected and the alternative hypothesis H_{a2} would be accepted.



H_{a2}: There is significant difference between academic performance of learners taught matrix using software and those taught matrices using traditional teaching method.

The significant difference observed between the control group and experimental group the posttest level indicates that the treatment administered to the experimental group was effective. The researcher therefore assumed that

the level of achievement of students in Matrices was greatly improved, hence learning take place. The achievement of the students taught by the use of instruction aids indicates that the teaching method used by the teacher influences the students' performance. This confirms the report of Ikeobi (1994) which states that lack of adequate approaches, methods and instructional aids ultimately presents problems to students learning, leading to poor performance and miss conception.

Based on the results of the data analysis presented, the following findings were reached:

1. The software application package was effective in learning Matrices and there was a significant difference in the achievement of Students in senior secondary schools mathematics.
2. The use of the software application package sustained and aroused students' interest toward learning matrices in Mathematics.
3. The experimental group who used the software package performed better than the control group that was taught by the traditional teaching method.

V. CONCLUSION

It has been accepted empirically (Ayodele, 2000) that learners comprehend better through practical works, and that the gateway to attain science and technology greatness is to integrate theory and practical works any time we are teaching science and technology subjects which includes Mathematics. This study has equally given a back up to the fact that students taught matrix with computer assisted instructions will learn better than those taught with the traditional teaching method.

Indeed, majority of our teachers are professionally committed, creative and skillful (Landu, 2000), what they probably lack is the encouragement to use educational technology instructions in teaching. The learning of the concept of matrices has, for a long time, been somehow confuse among students and the teachers because of its nature which makes it difficult for effective teaching and learning. Therefore, the need for mathematics is important, in that it is a precision tool used by all scientists. In their guess for knowledge and understanding about the physical world. We recommended that:

1. Teachers should employ the use of computer assisted instructions in teaching Matrices and other aspects of Mathematics in secondary schools.
2. The educational body or bodies concerned should provide practical materials to teachers and students in our schools.
3. Curriculum developers should identify and specify CAS packages for effective use in the Classroom so as to facilitate the achievement of educational objectives.
4. Introduction of CAS into teaching of matrices in all senior secondary schools.
5. Government, on her part, should provide computers to our secondary schools to enable students have access to computer individually so that they can study at their own peace and organize training programmes such as seminars, workshops and in-service training for Mathematics teachers so as to develop them professionally on computer literacy and proficiency.
6. Introduction of CAS into teaching of matrices in all senior secondary schools.

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