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EFFECTS OF LABORATORY AND HEURISTIC TEACHING STRATEGIES ON PERFORMANCE, RETENTION AND ANXIETY IN TRIGONOMETRY AMONG SENIOR SECONDARY SCHOOL STUDENTS IN KATSINA STATE, NIGERIA.

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ABSTRACT

The study examined the Effect of Laboratory and Heuristic Teaching Strategies on Performance; Retention and Anxiety in Trigonometry among Senior Secondary Students in Katsina State, Nigeria. The study developed three objectives and tested three null hypotheses. The study adopted Quasi-experimental design of the nonequivalent control group. The population of the study comprised of 17257 SS II students from 25 public Senior Secondary Schools in Katsina Zonal Education Quality Assurance. 177 students from 6 intact classes of SS II were sampled using purposive sampling technique for the study. Two validated

Introduction

Mathematics is a subject that uses carefully defined terms and concise symbolic representations, which add precision to communication (Obodo, 2013). Kolawole and Oluwatayo (2015) gave the concept of mathematics as a human invention, born out of human resolve to solve human problems. Borasi (2018) asserts that it is a science that draws necessary conclusions. Mathematics is the language of science and

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instruments, Trigonometry Performance Test (TPT) and Mathematics Anxiety Questionnaire (MAQ) with reliability coefficient of 0.76 obtained using Pearson product moment correlation coefficient were used for data collection. Research questions were answered using mean and standard deviation, while null hypotheses were tested using ANOVA, Independent sample T-test, Mann-Whitney U test and Krusall wallis H-test at $p \leq 0.05$ level of significance. The major findings revealed that, there was a significant difference in the mean academic performance, retention and anxiety level between those taught using laboratory and heuristic strategies and those taught using lecture method, it was concluded that the experimental groups, who were taught using laboratory and heuristic teaching strategies perform better than the control group who were taught using lecture method. It was concluded that both laboratory and heuristic teaching strategies are capable of improving student's academic performance, retention and reduce student's anxiety significantly. The study recommends among others that mathematics Teachers should implement the use of laboratory and heuristic teaching strategies to enhance academic performance, retention and reduce anxiety level of students.

Keywords: Performance, Retention, Anxiety, Mathematics, Laboratory, Heuristics

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Technology, without which there is no meaningful societal co-existence. Osokoya (2015) describes mathematics as a language of science. Aminu, in Adedeji (2018), argued that mathematics is not only the language of sciences, but essential nutrient for thought, logical reasoning and progress. Mathematics liberates the mind and also gives individuals an assessment of the intellectual abilities by pointing towards

direction of improvement. Adedeji (2018) concluded by saying that mathematics is the basis of all sciences and technology and therefore, of all human endeavors.

Researchers from countries other than Nigeria also viewed mathematics as being important. For instance, Funkywizard-ga (2014) expressed the importance of mathematics in terms of its advancement in science and our understanding of the workings of the universe. He also described mathematics in terms of its personal advancement of individual, both mentally and in workplace. This implies that every individual requires mathematical skills for personal progress and in job assistance. In support of the above, the British National curriculum (2004) stated that mathematics equips pupils with uniquely powerful tools to understand and change the world. These tools they remarked include, logical reasoning, problem solving skills and the ability to think in abstract ways. Moreover, mathematics is important in everyday life, in many forms of employment, science and technology, medicine, the economy, the environment, development and in public decision-making. This implies that an individual needs the study and understanding of mathematics to function well as a person or in work place.

The importance of mathematics in most fields of human endeavor cannot be underestimated. Its usefulness in science and technological activities as well as commerce, economics, education and even humanities is almost at par with the importance of education as a whole. Mathematics is useful virtually in all subjects because all fields of knowledge are dependent on it for solving problems and predicting outcomes (Adewale, 2018). The depth of mathematical knowledge an individual has dictates the level of accuracy of the individual's decision. This implies the fact that before an individual can function well in the society he/she must possess or have relatively good knowledge of mathematics especially in this era of technological age. In summary mathematics provides special skills required by an individual

to solve his/ her day-to-day problems, communicate effectively, reason appropriately and make necessary connections.

The technological development of a nation is highly rooted in the study of mathematics. Okereke (2016) opined that, mathematics is the foundation of science and technology and its functional role to science and technology is multifaceted and multifarious that no area of science, technology and business enterprise escapes its application. The place of mathematics in the life of any nation, according to Okereke (2016), is one which is inextricably linked with the place of development in that nation. Mathematics plays an indispensable role in realizing a nation's dream of rapid scientific and technological development. Indeed no nation that wants to develop scientifically and technologically can afford to neglect the mathematical components of her school curriculum. It is the researcher's believe that this important contribution of mathematics accounts for the Federal Government of Nigeria's inclusion of mathematics as a core subject in secondary schools of Nigeria to enhance the nation's quest for science and technology.

Trigonometry is a branch of mathematics that deals with the relationship of sides and angles in a triangle with the relevant function of any angle. At the secondary school level, it is a topic contained in senior secondary school syllabus taught at SS II level. West African Examination council (WAEC) and national examination council (NECO) examination questions cover all mathematics topics including trigonometry. So, understanding the topic and knowing how to solve question on it would boost the chances of students in passing WAEC and NECO mathematics examination. Despite the importance of mathematics, Maduabum and Odili (2016) observe that students lack interest in the subject and perform poorly in it. Ukeje, in Okigbo and Osuafor (2018), observe that mathematics is one of the most poorly taught, widely hated and very difficult to understand as a subject in both primary and secondary schools, students particularly girls run away

from the subject. The teaching strategy a teacher utilizes in teaching mathematic topics is important for effective teaching of the subject.

Due to the poor performances in mathematics examinations, various researchers in mathematics education have investigated the causes of the poor performance in the subject, where it was found that one of the reasons for these poor performances is attributed to poor approaches used in teaching the subject. In this regard, Yoloye in Anaduaka (2018) observes that the teaching of science, mathematics and technical subjects still tend to be traditional and devoid of some existing innovations in teaching strategies in these subjects. This traditional approach, Nwagbo, (2015) explains, is the approach in which the teachers deliver pre-planned lessons to the learners with or without the aid of instructional materials. Okorie in Nwagbo (2015) describes it as the telling method and noted that it places the teacher as the sole author of knowledge which he/she dispenses at will to the learners. By this approach it makes the learner passive which is not supposed to be. For teaching and learning to be effective, the learner has to be active not passive. Thus, there is the need to find methods and techniques to make learning of mathematics more meaningful and interesting so as to improve students' performance, retention and reduce the level of anxiety they have in mathematics. In view of this, the research work focuses on investigating the effects of laboratory and heuristic teaching strategies on student's academic performance, retention and anxiety in trigonometry among senior secondary school students in Katsina state, Nigeria.

Laboratory has been described as a room or a building specially built for teaching by demonstration of theoretical phenomenon into practical terms. With the laboratory experience, students will be able to translate what they have read in their texts to practical realities, thereby enhancing their understanding of the learnt concepts. Farombi (1998) in Yara (2010) posits the saying that seeing is believing is the effect of using laboratories

in the teaching and learning of science and other science related disciplines as students tend to understand and recall what they see more than what they hear. Laboratory is very important and essential to the teaching of science and success of any science course is much dependent on the laboratory provision made for it. Lending credence to this statement, Ogunniyi (1982) in Yara (2010) said that there is a general consensus among science educators that laboratory occupies a central position in science instruction. It could be conceptualized as a place, where theoretical work is practicalized and practicals in any learning experiences involve students in activities such as observing, counting, measuring, experimenting, recording and carrying out fieldwork. These activities could not be easily carried out, where the laboratory is not well equipped. There is usually a strong move to emphasize the dependence of science teaching on the existence of a well-equipped science laboratory.

At the beginning of the twenty-first century we are entering a new era of reform in mathematics education. Both the content and pedagogy of mathematics learning and teaching are being scrutinized, and new standards intended to shape and rejuvenate science education are emerging (National Research Council, 1996; 2010). The National Science Education Standards NSES, (2016) reaffirm the conviction that inquiry in general and inquiry in the context of practical work in mathematics education is central to the achievement of scientific literacy and quality education. Inquiry-type laboratories have the potential to develop students' abilities and skills such as: posing scientifically oriented questions, forming hypotheses, designing and conducting scientific investigations, formulating and revising scientific explanations, and communicating and defending scientific arguments. Tobin (2019) wrote that: “Laboratory activities appeal as a way to learn with understanding and, at the same time, engage in a process of constructing knowledge by doing science”. He also suggested that meaningful and quality learning is

possible in the laboratory if students are given opportunities to manipulate equipment and materials in order to be able to construct their knowledge of phenomena and related scientific concepts.

Laboratory teaching strategy which is based on learning by doing, enable students to carry out practical activities by themselves and communicating with each other during lesson period while the teacher stand to guide the students to enhance meaningful learning and also reduce mathematics anxiety. The laboratory teaching strategy is an activity method and it leads the students to discover mathematic facts and it is a procedure for stimulating the activities of students and to encourage them to make discoveries. It proceeds from known to unknown, concrete to abstract. It is a process of helping the weak students to understand mathematical concepts or ideas. It leads students to the formation of concepts out of experiences with discrete objects and in this case the vague theories and imaginary objects take real shape and the students understand better and perform better in mathematics. Heuristic teaching strategy can also be regarded as the discovery or inquiry teaching strategy. It is a process of allowing the students to take the leading role in their own learning experiences. The teacher is a facilitator and guide, making it possible for the learners to reach mutually agreed-upon goals. The teacher serves as a resource person to stimulate, motivate, clarify, and explain.

The Heuristic teaching strategy, in general, models the scientific method. This method of teaching can be applied to just about any subject matter and is designed to engage the students in learning. The role of the teacher is to step back from their traditional role of direct instruction, and become a facilitator to clarify, explain, pose questions, suggest organizational and problem solving strategies, and mediate a class discussion, all the while resisting telling the students how to do something or just providing the answer. The teacher is there to guide them in the right direction so that they solve the problem, and will let them think through and figure the

problem out on their own whenever possible. Thus, the idea is to ask questions to make sure they know what is going on, and become active in their learning. Asking appropriate questions is key to this method. These questions can be specific questions to keep them thinking on the correct path, or less specific questions to generate discussion among the whole class. If the students start to stray from the correct method or reasoning, the teacher lets them. It is part of the exploring, but the teacher brings them back with questions for them to think about. After getting the correct answer, the teacher does something more than just telling the students that they are correct, the teacher poses follow up questions to test and challenge their understanding of the problem itself.

The laboratory and the heuristic teaching strategies are seen as useful tools for helping students learn about the structure of knowledge and the process of knowledge production. The abstract nature of mathematics should be reduced through demonstration, inquiring, discovering and practical methods. It is important therefore to consider methods and strategies that may help to improve the performance, with the view of considering their effect on teaching and learning of mathematics. Purdy and Luepruti in Agommuoh (2019), in trying to explain the concept retention noted that the ability to remember takes place more effectively when experiences are passed across to the learner through an appropriate instructional strategy which is capable of arousing students' interest. Retention is therefore a necessary factor for students to properly apply learnt concept. Retention is the ability to store facts and remember things easily. This implies that if there is no proper storage structures developed in the learners, information recalling may be marred and consequently resulting to poor performance.

This structure is what Ausubel in Ogbonna (2017) referred to as cognitive structure, which was defined as, every information pertaining to one's life experiences. Further on this, Ausubel noted that when students' learn new

things and relate the new ideas to what is already stored and get them organized into more complete cognitive structure, then, they are engaged in more meaningful reception learning that leads to retention. This is why; the teacher must be able to make learning meaningful to the students, by presenting the materials or information to be learnt in various forms; give students the opportunity to use the information that would often enhance fast learning, to enable its storage in the memory. When this is done, the information can be easily recalled because learning is permanent as far as the idea is concerned and the students' has used it in various forms.

Mathematics Anxiety (MA) is defined as feeling of tension, apprehension, or fear that interferes with mathematics performance or tasks. (Ashcraft, 2002). Individuals who confronted negative thoughts or feelings have a greater tendency to avoid math-related activities due to their experience in learning (Andrews & Brown, 2015). In addition, Mathematics Anxiety can also lead to serious psychological and psychosomatic problems if not properly addressed (Pletzer et al., 2015). This is because students who experience Mathematics Anxiety engage in two things at once; dealing with mathematical tasks complexity and overcoming negative feelings or thought. As a result, students' confidence level and mathematics performance will be affected, subsequently leads to a situation where students are no longer interested in learning mathematics (Arslan, 2020). Therefore, MA should be taken seriously as previous evidence suggests that Mathematics Anxiety has a negative impact on students' achievement at all levels (Ersozlu & Karakus, 2019), affect students' abilities (Jatisunda et al., 2020) and contributes to students' failure in mathematics (Fong et al., 2017).

In every educational classroom, there are some students with mathematics anxiety to be considered in teaching and learning, that is why the study focuses on investigating the effect of laboratory and heuristic teaching strategies to find out how it will help in improving students

learning, performance, retention and how it will reduce the level of anxiety in them.

Statement of the Problem

Evidence of poor performance and anxiety in mathematics by secondary school students have been reported by researchers such as Musa and Maat, (2021). This has in turn affected the technological, scientific and business development in Nigeria. The poor performance has been linked to teacher's dominance in the teaching and learning processes. Students' participation is usually very minimal. For teaching and learning to be effective, the students' have to be active participants in the learning process. The causes of anxiety have been linked with the perception of mathematics as one of the most difficult subjects to learn due to its complexity and abstract nature. (Azizah & Suhendra, 2020; Haase et al (2019). It has also been noted that one of the reasons for this poor performance and fear of the subject (anxiety) is attributed to poor methods used in teaching the subject. This makes it pertinent to seek for methods for teaching mathematics that aims at improving its understanding, performance retention and reduces the level of anxiety by students. The laboratory and heuristic teaching strategies are some of the strategies which encourages students' active participation in the teaching and learning of mathematics. The WAEC chief-examiners' annual reports and comments (2013) showed that students' performance are not encouraging. Hence the study is design to find out the relative or comparative effects of laboratory and heuristic teaching strategies on students' academic performance, retention and anxiety in senior secondary school mathematics which of these two strategies will be better in improving students' performance, retention and reduce their anxiety in learning mathematics.

Objectives of the Study

The study will be undertaken to investigate the effects of laboratory and heuristic teaching strategies on students' academic performance, retention

and anxiety in trigonometry among senior secondary school students in Katsina state, Nigeria.

Specifically the study was intended to:

1. Determine the effect of laboratory and heuristic teaching strategies on the academic performance of students in trigonometry.
2. Find out the effect of laboratory and heuristic teaching strategies on students retention in trigonometry.
3. Investigate the effect of laboratory and heuristics teaching strategies on mathematics anxiety among senior secondary school students.

Research Hypotheses

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

Ho_1: There is no significant difference between the mean academic performance scores of students taught trigonometry using laboratory and heuristic teaching strategies and that of their counterparts taught same using Lecture Method.

Ho_2: There is no significant difference between the mean retention ability scores of the students taught trigonometry using laboratory and heuristic teaching strategies and that of their counterparts taught same using Lecture Method.

Ho_3: There is no significant difference between the mean mathematics anxiety rating scores of the students taught trigonometry using laboratory and heuristic teaching strategies and that of their counterparts taught same using lecture method.

Methodology

The study adopts the quasi-experimental design of the non-equivalent control group. Pretest, posttest and follow up test were administered to the subjects. The non-equivalent control group design was considered

appropriate for this study because subjects were not randomly assigned to the comparisons group. Rather treatment was randomly assigned to intact classes or groups, which was organized, so that the school settings in terms of classroom arrangements and schedules of lessons would be preserved

The population of the study is made up of 17,257 SS II students comprising of 8,649 males and 8,608 females. These are students in their second year of the senior secondary school stage and are spread across the entire senior secondary schools in Katsina ZEQA. Katsina ZEQA comprises 25 public senior secondary schools from the three local governments (i.e Jibia, Kaita and Katsina). The average age of members of the population is 17 years. A sample size of 177 students was selected from three secondary schools within the study location. This sample size is considered adequate for the study based on the suggestion that for a parametric test to be used, 30-500 students would be necessary as sample size. Also the central limit theorem posits that a minimum of 30 samples is needed for an experimental study. These two conditions have been met by the study, hence the adoption of the sample size.

The research instrument for the study is made up of the Trigonometry Performance Test (TPT) and a Mathematics Anxiety Questionnaire (MAQ). The TPT was used to measure the students' academic performance and retention in Trigonometry. Thus it was used for both pre-test and post-test as well as the follow-up test in the assessment of the students attainment in Trigonometry. The TPT consist of 30 multiple choice test items in trigonometry which were adapted by the researcher from past WEAC and NECO questions. Also the questionnaire is made of 20 statements which are based on feeling of anxiety a student has towards mathematics lesson or test. The students are required to tick on how closely they agree or disagree to a statement. The questionnaire contain 5 options ranging from strongly agree to strongly disagree, (SA, A, UD, D, SD).

Result

H_{01}: There is no significant difference between the mean academic performance scores of the students taught trigonometry using laboratory and heuristic teaching strategies and that of their counterparts taught same using Lecture Method.

Table 1: Summary of ANOVA on significant difference in performance scores of students in experimental group I, experimental group II and control group.

Source	Sum of Squares	Df	Mean Square	F	Sig.	Remark
Between groups	27499.67	2	13749.83	507.82	0.00	Significant
Within groups	4467.60	165	27.08			
Total	31967.28	167				

Significant at $P \leq 0.05$

Table 1 shows that there was significant difference between the mean performances scores of students in experimental group I, experimental group II and control group ($F(2, 165) = 507.82$, $P < 0.05$). Therefore, the null hypothesis which state that there is no significant difference between the mean academic performance scores of the students taught trigonometry using laboratory and heuristic teaching strategies and that of their counterparts taught same using Lecture Method is rejected. Since the result indicated difference there is need to identify the location of the difference, to do so, a post hoc test was carried out.

Table 2 Scheffe posthoc comparisons of retention of students by groups.

(I) grouping	(J) grouping	Mean Difference (I-J)	Std. Error	P-Value	Remark
Exp. Grp I.	Exp. Grp II	2.93	0.95	.061	Not significant
	Control Grp	30.27	1.06	0.00	Significant
Exp. Grp. II	Exp. Grp I	2.93	0.95	0.61	Not Significant
	Control Grp	27.33	0.98	0.00	Significant
Control Grp.	Exp. Grp. I	30.27	1.06	0.00	Significant
	Exp. Grp II	27.33	0.98	0.00	Sig.

Significant at $P \leq 0.05$

Table 2 shows that there was no significant difference in the performance of students in experimental groups 1 and 2 ($p = 0.061$) at 0.05 level of significance but significant difference existed between experimental groups 1 and control group ($p< 0.05$) and between experimental group 2 and control group ($p< 0.05$) in favor of the experimental groups. This shows that the students taught trigonometry using laboratory and heuristic teaching strategies perform better than their counterparts taught using lecture method.

Ho_2: There is no significant difference between the mean retention ability scores of the students taught trigonometry using laboratory and heuristic teaching strategies and that of their counterparts taught same using Lecture Method.

Table 3 Summary of ANOVA on significant difference in Retention scores of students in experimental group I, experimental group II and control group.

Source	Sum of Squares	Df	Mean Square	F	Sig.	Remark
Corrected Model	21297.13	3	7099.04	226.33	0.00	
Intercept	55597.68	1	55597.68	1772.56	0.00	
Pretest	26.76	1	26.76	0.853	0.357	

Groups	20688.99	2	10344.50	329.80	0.00	Significant
Error	5143.99	164	31.36			
Total	253924.00	168				
Corrected Total	26441.12	167				

Significant at $P \leq 0.05$

Table 3 presented the Summary of ANOVA on difference between the mean retention scores of \students in experimental group I, experimental group II and control group ($F(2, 168) = 329.80$, $P<0.05$) therefore the null hypotheses was rejected it. This indicates that significant difference exists to identify the location of the difference post hoc test was carried out.

Table 4: Scheffe Post hoc Comparisons of Retention of students by groups.

(I) grouping	(J) grouping	Mean Difference (I-J)	Std. Error	P-Value	Remark
Exp. Grp I.	Exp. Grp II	-0.64	1.03	0.825	Not significant
	Control Grp	24.86	1.14	0.000	Significant
Exp. Grp. II	Exp. Grp I	0.64	1.03	0.825	Not Significant
	Control Grp	25.49	1.06	0.000	Significant
Control Grp.	Exp. Grp. I	-24.86	1.14	0.000	Significant
	Exp. Grp II	-25.49	1.06	0.000	Significant

Significant at $P \leq 0.05$

Table 4 shows that there was no significant difference in the retention score of students in experimental groups 1 and 2 ($p = 0.825 > 0.05$) but significant difference existed between experimental groups 1 and control group ($p = 0.00 < 0.05$) and between experimental groups 2 and control group ($p = 0.00 < 0.05$) all in favor of experimental groups. This shows that students taught trigonometry using laboratory and heuristic teaching strategies retained better than those taught using lecture method.

H_{03}: There is no significant difference between the mean mathematics anxiety rating scores of the students taught trigonometry using laboratory and heuristic teaching strategies and that of their counterparts taught same using lecture method.

Table 5: Kruskal-Wallis Test on students anxiety in experimental group I, experimental group II and control group.

Groups	N	Mean Rank	Median	DF	H-Value	P-Value	Remark
Experimental Grp I	51	73.25	68.00	2	143.432	0.00	Significant
Experimental Grp II	71	132.10					
Control Group	46	23.50					
Total	168						

Significant at $P \leq 0.05$

Table 5 presented the Summary of H-test on difference between the mean anxiety rating scores of students in experimental group I experimental group II and control group ($H_{(2)} = 143.432$, $P<0.05$) it indicates significant difference exist. Consequently, the null hypothesis which states that there is no significant difference between the mean mathematics anxiety rating scores of the students taught trigonometry using laboratory and heuristic teaching strategies and that of their counterparts taught same using lecture method is rejected.

Discussion

Findings number one showed that the mean and standard deviation of students' performance scores taught trigonometry using laboratory and heuristic teaching strategies and that of students' thought using lecture

method for each of the groups, the posttest mean scores were greater than the pretest mean scores with the group taught using laboratory teaching strategy having a higher mean gain. This is an indication that laboratory teaching strategy had more effect on students' performance in trigonometry than the heuristic teaching strategy. The result from the test of hypothesis one also showed that, there was a significant difference ($p<0.05$) between the mean performance scores of students taught trigonometry using laboratory and heuristic teaching strategies and that of their counter parts thought same using lecture method. The finding of the study is consistent with Okigbo and Osuafor (2008) who investigated the effect of using mathematics laboratory in teaching on students' achievement in junior secondary school mathematics and found that the use of laboratory method of teaching enhanced students' achievement in mathematics more than the lecture method. The finding of the study also agrees with Odili (2006) who stated that laboratory teaching method is an activity method that leads the student to discover mathematical facts. It is based on the principles of learning by doing, learning by observation, and proceeding from concrete to abstract. It can be seen from the finding of this study that laboratory teaching strategy is more effective in teaching mathematics and leads to students' better performance than the heuristic teaching strategy.

Findings number 2 showed that the mean retention scores of experimental group 1 differ from that of experimental group II. The mean retention scores of experimental group 1 also differ from that of control group and experimental group 2 differ from that of control group. This indicates that students in the experimental groups performed better than their counterparts in the control group. Hence students in the experimental groups appeared to retain the trigonometric content taught more than those in the control group. The retentive effect of both the laboratory and heuristic teaching strategies can be seen from the fact that both the two are

based on learning by doing which enhance meaningful learning and retention ability. The meaningfulness of the mode of presentation facilitated the encoding of the learnt concepts into memory. The constant practice of both previous and present concepts adopted by both the laboratory and heuristic teaching strategies is capable of causing overlearning which is found to cause remembering and enhances retention. This also agrees with Nwamuo (2006) who noted that overlearning has been recommended by psychologists for remembering purposes. This finding agrees with Obodo (1990), Ogbonna (2007) and Agomuoh (2010) who found teaching method efficacious in enhancing students retention in mathematics and physics.

Finding number 3 showed that the mean rank scores of students in experimental group I differ from that of students in experimental group 2 and that of students in control group. This explains that students in experimental group 2 experience less anxiety than the students in experimental group 1. Also students in experimental groups have less anxiety level than students in control group. This shows that laboratory and heuristic teaching strategies have effects in reducing students' anxiety in trigonometry this is in consistence with the finding of Oyenekan et al (2018) which found out that mathematics anxiety factors does not have the same effect on students' performance but exerts joint effects.

Conclusion

From the foregoing discussions based on the results of the study, the following conclusions were made.

Laboratory teaching strategy has more effect on students' performance in trigonometry than the heuristic teaching strategy. There was a significant difference in the mean retention scores of students in the experimental and control groups, with the experimental group having a higher mean score in the follow up test than the control group. Laboratory and heuristic teaching strategies help in reducing students' anxiety level significantly.

Recommendation.

On the basis of the findings of this study, the following recommendations were made.

1. Teachers of mathematics should try as much as possible to learn to teach mathematics with laboratory method of teaching. This will help to enhance students' understanding of the subject.
2. For teachers, an enlightenment program should be provided in the form of seminars and workshops on the use of laboratory teaching strategy, this will help the teachers to acquaint themselves with the necessary skills needed for proper teaching.
3. Since both laboratory and heuristics teaching strategies have been empirically and statistically proven to enhance the quality of academic performance and retention of students in mathematics then teachers should therefore encourage their application in the classrooms. Curriculum planners and school supervisors should facilitate their practical application in mathematics lesson.
4. Government should ensure efficacious implementation of the recommended application of laboratory and heuristics teaching strategies in the senior secondary schools. While faculties of education, institutes of education, colleges of education and teachers' training institutes should emphasize the use of these strategies in their methodology courses, and should ensure their practical application in teaching and learning process.
5. Both practicing teachers and student-teachers should be given easy access to capacity building programs through workshop, conference, seminar, symposium and exhibition on laboratory and heuristic teaching strategies
6. Adequate provision of mathematics laboratories, resource room, classrooms, textbooks, furniture and other relevant resources

should be made available by the government for proper application of the two strategies.

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