EFFECTS OF GUIDED DISCOVERY ON KNOWLEDGE RETENTION AND ACHIEVEMENT IN CHEMISTRY AMONG STUDENTS IN TERTIARY INSTITUTIONS IN SOUTH EAST, NIGERIA.

Amadi, Victoria Chinyere (Ph.D)[1]
Ugorji Clifford (Ph.D)[2]
Felicia Onuabuchi King-agboto (Ph.D)[3]

Department of Physical Science Education [1, 2 & 3]
Imo State University, Owerri

Abstract

This study investigated the effect of guided discovery and lecture methods on students' knowledge retention and achievement in chemistry in tertiary institution. Four research questions and four null hypotheses guided the study. Quasi-experimental design of two comparism group method was adopted. A sample of 60 students was randomly drawn from the population of one hundred and twenty four (124) year three tertiary institution students of Department of Chemistry education Imo State University Owerri and Federal College of Education Umunze. The instrument used for data collection was Chemistry Achievement Test which was validated by experts. The reliability of the instrument was determined using Kuder Richardson 21 (Kr-21) correlation method and a reliability coefficient of 0.84 was established for the study. The data generated were analyzed using mean and Analysis of Covariance (ANCOVA). The study concluded that the guided discovery method had more effect on students' academic achievement and level of knowledge retention than lecture method. Recommendations were made among others including organizing in-service training for teachers on the effective method,(using activity based methods like guided discovery method) for teaching chemistry in tertiary institutions.

Keywords : effects, guided discovery, knowledge retention, and chemistry student.

Introduction

Learning implies a relatively permanent change in the behavior of the student. This depends largely on effective teaching which is done by utilizing certain teaching methods. The current public outcry on standard of education at all levels of education in the country is hinged on the apparent shortfalls in academic performances of many students and poor level of knowledge retention amongst students even on a short term level. Although frantic efforts have been made to rectify this situation through some innovations, the problem still persists. The poor level of knowledge retention amongst students in Nigerian tertiary institutions is so alarming that students often do not recall most of what have been taught them even within hours. This could be associated with the method of teaching in tertiary institutions. A cursory look at the Nigerian school system shows that the teacher centered methods of teaching (of which the lecture method is the most commonly used) is prevalently used to

teach students at all levels of education in the country.

Chemistry is a core science subject that is taken very seriously in the school system, irrespective of level of education. Chemistry as a subject is experimental in nature and required to be taught by use of variety of instructional strategies which are activity-based. These activity-based strategies are required in order to drive the content to learners' level of understanding. For example the guided discovery, concept mapping, use of analogy, computer-assisted instruction and other learner friendly strategies which have come to stay in the teaching business are fall-out of science education research reports.

In terms of curriculum relevance, chemistry is a compulsory subject at secondary school level for every student who intend pursuing any science course in the tertiarylevel. Students feel anxiety towards chemistry and thus anxiety affects their performance in chemistry. Over the years, students' performances in ordinary level examinations in chemistry have not been that good. According to Amadi and Acholonu (2014) poor performance of students in public secondary and tertiary schools have been attributed to many factors among which are; teaching methods, lack of test construction skills by teachers, inadequate instructional facilities and equipment necessary for teaching. It has already been pointed out that poorly designed tests could make the students loose interest in a subject. Chemistry as a subject is not excluded. Based on observations of chemistry students both secondary and tertiary, the information shows that the students are not actively involved in developing knowledge; they receive information passively and are less motivated. This passivity has caused much concern among educators because knowledge of chemistry especially in the tertiary level plays a significant role in enhancing the country's technological development. These could be as a result of the widely used conventional method of teaching by most of the chemistry teachers teaching chemistry in secondary and tertiary levels.

Teaching method is defined as a way of doing the teaching business, the procedure and orderliness in planning and execution of teaching proper with the appropriate instructional materials to achieve classroom teaching objectives (Mkpa 2009). According to Anyanwu, Izuagba, Obiefuna and Ofuruobi (2009), teaching method is the overall procedure by which the process of an instruction is organized and executed. Teaching methods refers to the series of actions or activities planned by the teacher and systemically provided to the learner to enable him receive and process the information, retain and recall them in order to be able to use them to tackle emerging life tasks and problems (Anyanwu, et al, (2009).

Retention of knowledge is the process that involves the storage and effective recall of information or experiences which the learner is exposed to. It is very important to curriculum evaluation because it determines the level of permanency of the behavioural change of the learner.

During the process of curriculum implementation serious attention is paid on best way to ensure that effective learning occurs and what is learned is retained over a long period of time. Curriculum innovations in instructional strategies mostly aim at achieving this major objective. However, with all these

innovations there is still not much improvement in learners academic performances in most of our institutions of learning and learners readily forget most of the things they are taught as soon as the class ends. This unsatisfactory situation may be ascribed to the prevalent teaching methods used in schools in Nigeria. Uwameije and Ogunbameru (2015) discovered that the traditional methods like lecture method, are still heavily used to teach subjects in most Nigerian schools especially in the tertiary institutions. In this method of teaching the learners are passive and submissive to the teacher as they rigidly and religiously follow the teacher's directives (Mkpa 2009).

Many researchers like Okafor, Nwike and Chukwudum (2009) agree that the conventional or traditional method does not help students to construct their own understanding. Amadi (2014) opined that the uninspiring lecture teaching methods adopted by chemistry teachers lead not only to low performance but also incapacitates students from developing required skills necessary for creative thinking. In this method, the teacher presents a verbal discourse on a particular subject, theme or concept to the learners, the teacher deliver preplanned lessons to the students with little or no instructional ideas. Most of the time, during teaching- learning process, instruction remained unilateral which is considered to be orthodox activity.

Activity-based methods of teaching are considered more effective alternative to traditional/conventional or teacher centered teaching methods. Activity-based method is student (learner) centered approach that is taught through many different activities (Dorjiss 2013). In this method of teaching, the students or learners are more active than the teacher as they investigate, explore, interact, question and apply knowledge (Anyanwu et al 2009). It promotes better understanding of a lesson as it is learning by doing. Ethics are usually formed when using activity-based. It enhances self-efficacy in the learner. It gives learners opportunities to work independently and in group. It inspires the students to apply their creative ideas, knowledge and minds in solving problems (Dorjiss 2013). The activity-based teaching methods makes the teaching and learning exercise more practical and meaningful to the learners which may encourage high level of knowledge retention amongst learners. A common example of an activity-based method of teaching is the Guided Discovery Method. According to Abramson(2018), Guided discovery is a learning method that encourages students to discover concepts on their own through the guided facilitation of their teacher. He is of the view that this method allows students to explore knowledge and information individually or in group, with the help of leading questions from the teacher, and draw conclusions and make connections that will lead to the achievement of learning objectives (Abramson, 2018). He further explained guided discovery method as a powerful and engaging tool that promotes or increase student involvement and retention of the subject matter. In this method the teacher must guide the students toward the discovery. This can be accomplished by providing appropriate materials, a conducive environment, and allotting time for students to discover. Guided discovery is characterized by convergent thinking (Labush 2014). The teacher devises a series of statement or questions that guide the learner. It follows logical step by step process involving a series of

discoveries done by students leading to a single predetermined goal. In other words, the teacher initiates a stimulus and the learner reacts by engaging in active inquiry thereby discovering the appropriate response (Mest 2006).

Iwuji (2012) in his research study on the effect of Guided discovery teaching method on academic achievement and retention in basic science concepts among junior secondary school students found out that there is a significant difference in the academic achievement and retention of students taught basic science concepts using Guided discovery and those taught same concepts using lecture method. He revealed that in Guided discovery method students develop the feeling of working in directive and interaction which always leads to a considerable degree of discovery, clarity and retention of concepts. He concluded that Guided discovery is a cooperative learning strategy and that the teaching strategy teachers employ in science teaching has significant effects on students' achievement and retention of the learned concepts.

Chianson, Kurumeh and Obida (2010) carried out research on effect of cooperative learning strategy on students' retention in circle geometry in secondary schools and found out that students who were subjected to the cooperative learning strategy were able to retain the concepts of circle geometry more than those students who were taught using conventional learning approach. They concluded that retention have a lot of connection to activity.

Knowledge retention is the proportion of knowledge retained by an individual after a specific retention interval (Bruno, Ongaro and Fraser, 2007). A retention interval is defined as the time that elapses between a test of original learning and a retention test (Bruno, et al 2007). Knowledge retention is the condition of retaining (keeping) something especially information, ideas and skills acquired through formal and non-formal instructions. Dale (1969) reflected in his "cone of learning" that the activities performed in the process, the senses used and the nature of the involvement has a clear influence on retention. He also maintained that the effectiveness of learning or the learning retention rate is based on the teaching method, learning experiences and the media that was used for the instruction. This is shown in the following table.

Teaching method/media	**Knowledge retention**
See/hear-lecture	5%
Reading	10%
Audio-visual/video	20%
Demonstration	30%
Discussion group	50%
Practice	75%
Teaching others	90%
Immediate application of learning in real situation	90%

(Source: Dale 1969)

Knowledge retention can be long term and short term long term retention involves the recall and use of knowledge after a relatively long period of time has passed, since instruction on that knowledge. Also, short term retention involves the recall and use of time knowledge after a relatively short period of time has passed since instruction on that knowledge. A post-test given immediately after the instruction is not a retention test. A retention interval (the time between the end of instruction and the test) should be at least as long as the time of the instruction (the time between the beginning and end of the instructional period of the study). Difference between control and treatment instruction tend to be harder to detect at longer retention intervals but the longer the interval at which a difference is detected the greater the evidence of the treatment leading to long-term retention. The justification for using retention tests is both empirical and theoretical, but comes down to both data and theory supporting the claim that test results can sometimes be different at retention than at immediate "normal post-test".

Hermann Ebbinghanus (2000) proposed a theory of knowledge and retention which is also known as forgetting curve. This theory was credited to him because he developed a formular for forgetting and then conducted a study to prove the theory. He discovered an exponential nature of forgetting with a shockingly rapid rate of memory decline occurring in just minutes after an instruction. Ebbinghaus' formula was based on two fundamental concepts. The first is strength of memory which is unique to everyone. The second is the amount of time that has passed since learning. One key thing to note is his theory does not reflect everyone and their ability to retain information overtime because some people have extremely good memories whereas others are constantly forgetting things.

However, Ebbinghaus was able to provide clarity in the somewhat foggy area of knowledge retention rates and his findings have been widely accepted as the generaltheory for how we learn and retain information. According to Ebbinghaus' findings, two days after learning have occurred after an instruction, only 25% of the information is retained. Several other studies have found the forgetting curve to be even steeper with75% of information lost after just 24 hours and 90% of the information on learning acquired lost after one week. This theory of knowledge and retention over time is relevant to the present study because this study intends to determine the level of retention of students over time after exposing them to two treatments using Guided discovery method and lecture method. This exercise recognizes the fact that people normally forget what they learn over time. However, considering the role teaching method contributes to remembering and knowledge retention, this study intends to compare treatments with regard to which of the pair; guided discovery method or lecture method, enhances more retention amongst students in tertiary institutions, in south-east states. Specifically, the study sought to determine the effect of guided discovery method of teaching in the achievement and knowledge retention among chemistry students in tertiary institution.

The conventional teaching method lacks students' cooperation and interaction required for effective learning of the difficult chemistry concepts. Adequate students' cooperation and interaction are required for over learning and transfer of

learned chemistry concept, (Okoro, 2010). Such cooperation and interaction are found in guided discovery method. The problem of this study is to find an effective teaching method that can improve students' knowledge retention in chemistry. This work therefore intended to examine the effects of guided discovery method in tertiary students' knowledge retention in chemistry. Specifically, the study sought to determine the effect of guided discovery in the achievement and knowledge retention in chemistry among students in tertiary institution.

In other to achieve the objectives of this study, the following research questions and hypotheses tested at 0.05 level of significance guided the study;

- What is the difference between the mean achievement scores of students taught some selected topics in chemistry using guided discovery method and those taught same topics using lecture method in tertiary institutions.
- What is the difference between the mean achievement scores of students taught same selected topics in chemistry in University and College of education using the guided discovery method.
- What is the difference between the mean knowledge retention scores of students taught some selected topics in chemistry employing guided discovery and those taught same topics using lecture method in tertiary institutions.
- What is the difference between the mean knowledge retention scores of students taught same selected topics in chemistry in university and college of education using the guided discovery method.

Ho_1: There is no significant difference in the mean achievement scores between students taught some selected topics in chemistry using the guided-discovery method and those taught same topics using lecture method in tertiary institution.

Ho_2: There is no significant difference between the mean achievement scores of students taught same selected topics in chemistry in University and in College of education using guided discovery method.

Ho_3: There is no significant difference between the mean knowledge retention scores of students taught some selected topics in chemistry using guided discovery and those taught same topics using lecture method in tertiary institution.

Ho_4: There is no significant difference between the mean knowledge retention scores of students taught same selected topics in chemistry in university and in college of education using guided discovery method.

Method

This study adopted quasi-experimental design of two treatment comparison. The study employed pretest, post-test control group with follow-up test design. The population of this study comprises of one hundred and twenty four (124) year three tertiary institution students of department of chemistry education, Imo State University Owerri and Federal College of Education Umunze Anambra State. The sample of the study consisted of 60 students from the two tertiary schools who were randomly drawn from the entire population. The drawn students

were also randomly assigned to two groups; experimental and control. Both schools are government owned tertiary institutions that operate similar degree programmes using the same minimum standard curriculum for university education in the country under the National university commissions' supervision. The instrument for data collection was Chemistry Achievement Test (CAT) developed by the researchers. The instrument was developed to measure the cognitive performance of the students before and after treatment and their knowledge retention level after treatment. The CAT consisted of 50 multiple choice items drawn from the selected topics in the scheme of work. The instrument was administered to both the control and experimental groups (pre-test). The experimental group was then exposed to teaching using activity-based (guided discovery) method for 5 weeks and carryout evaluation. The control group was also taught the same thing for the same period (for 5 weeks) using lecture method and carryout evaluation. A follow-up test was carried out 16weeks (4months) after the post-test. This was given to students in the experimental groups in order to compare the extent to which the knowledge gained after the treatment by students was retained overtime. The researchers developed a test-blue print used in constructing the instrument. The instrument was validated by five experts, three specialist from department of science education (chemistry) and two specialists from measurement and evaluation unit, all from the two institutions involved in the study. The reliability coefficient of the instrument was determined using Kuder-Richardson formula (K-R_{21}) and the reliability index of 0.84 was obtained from the instrument. The data collected during the pre-test, post-test and follow-up test were statistically analyzed using mean and Analysis of Covariance (ANCOVA) for the research questions and null hypothesis at 0.05 level of significance respectively. Some measures were taken to control the extraneous variables that may compound the efficacy of the results of the treatment. They include the following; the same themes were used in teaching the two groups. The researchers and the research assistants administered all tests. The researchers and the research assistants were lecturers in the two schools. The students see them as performing their regular duties. This is done to remove students' suspicions as it aided in concealing the purpose of the activities from the students and minimized the teacher factor influence. Same period of time was given to the two experimental groups. To avoid infiltration of members of one group into another, the researcher and research assistants identified members of each group by keeping a list of their names and also by constantly checking the members of each group. Test instruments were strictly secured. None were allowed to get into hands of the students before assessment. All the groups' treatment activities and test administration were carried out under the same classroom conditions. Other variables were controlled by the use of ANCOVA which helped to remove from the treatment those differences which could be linearly correlated with variance and adjusted the post treatment means for difference between the other groups in the study.

Result

Table 1a: Mean pre-test and post-test performance scores of tertiary students taught with Guided discovery and lecture teaching methods.

Test	Achievement	Pre-test	Post-test
Group	n	X	X
Guided discover	30	24.46	42.06
lecture	30	25.26	25.14

Table 1a, shows the mean performance scores of students taught with guided discovery and lecture methods at pre-test and post-test. The table shows that students under the guided discovery method had a pre-test mean score of 24.46 while at post-test their score increased to 42.06. Also students under the lecture method had a pre-test mean score of 25.26 but their scores at post-test were still minimal at 25.14. This led to the conclusion that guided discovery teaching method is more effective on the academic achievement of chemistry students than the lecture method. This implies that guided discovery method is effective in teaching and learning of chemistry.

Table 1b: One way Analysis of covariance (ANCOVA) for mean achievement scores of students taught with guided discovery and lecture teaching methods at post-test.

Source of variation	SS	df	MS	F-Cal	F-crit	Decision
Adjusted mean	489.655	1	489.655	46.307	4.00	Ho Rejected
Error	613.292	58	10.574			
Total		59				

F-Cal = 46.307

F-Crit = F (df,∝)

= F (1, 58, 0.05)

= 4.00

; F Cal > F Crit, Reject Ho.

The above table revealed that the F-Calculated value for post-test effect is 46.307 and the F-Critical value of 4.00 from F (1, 58, 0.05) i.e. degree of freedom 1 and 58 at 0.05 level of significant. Since the F-Calculated value is greater than the F-critical value, this led to the conclusion that there is significant difference in the mean achievement scores of students taught with guided discovery and in lecture teaching methods. This implies that guided discovery teaching method is significantly effective on tertiary chemistry students' academic achievement.

Table 2a; Mean pretest and post-test performance scores of tertiary students taught with only guided discovery method.

Test	Achievement	Pre-test	Post-test
School type	n	X	X
University	15	24.09	42.19
Coll. Of Educ.	15	24.84	41.92

Table 2a shows the mean achievement scores of university and college of education students taught with guided discovery teaching method at pre-test and post-test. The above analysis shows that guided discovery teaching method is effective on improving the academic achievement of tertiary students be it university or college of education.

Table 2b; One way Analysis of Covariance (ANCOVA) for mean achievement scores of University and College of Education students taught with Guided discovery teaching method at post-test.

Source of variation	SS	df	MS	F-Cal	F-crit	Decision
Adjusted mean	26.9028	1	26.9028	0.2532	4.20	Accept
Error	2975.1527	28	106.26			
Total		29				

F-cal = 0.2532

F-crit = F (df, ∝)

= F (1, 28, 0.05)

= 4.20

;F-cal< F-crit, Accept Ho_2:

The above table revealed that the F-calculated value for post-test effect is 0.2532 and F-critical value of 4.20 from (1, 28, 0.05) i.e. degree of freedom 1 and 28 at 0.05 level of significant. Since the F-calculated value is less than the F-critical value, this led to the conclusion that there is no significant difference in the mean achievement scores of students taught with guided discovery in the University and College of Education. This implies that guided discovery teaching methods is significantly effective and has no interaction effect with type of school, university or college of education.

Table 3a; Mean Post-test and follow-up test Achievement scores of students taught with Guided discovery and lecture teaching methods.

Test	Achievement	Pre-test	Post-test
Group	n	X	X
Guided discovery	30	42.06	43.08
Lecture	30	25.14	25.06

Table 3a, shows the mean knowledge retention scores of students taught with guided discovery and lecture methods at post-test and follow-up test. The table shows that students under the guided discovery method had a post-test mean score of 42.06 while at follow-up test their score increased to 43.08. Also students under the lecture method had a post-test mean score of 25.14 with almost the same score of 25.06 at the follow-up test. This led to the conclusion that guided discovery teaching method is more effective on the knowledge retention of chemistry students than the lecture method.

Table 3b; One way Analysis of Covariance (ANCOVA) for mean knowledge retention scores of students taught with Guided Discovery and lecture teaching method at follow-up test.

Source of variation	SS	df	MS	F-Cal	F-crit	Decision
Adjusted mean	496.732	1	496.732	47.593	4.00	Ho Reject
Error	605.317	58	10.437			
Total		59				

F-cal = 47.593

F-crit = F (df, $\propto$)

= F (1, 58, 0.05)

= 4.00

; Fcal>Fcrit, Reject Ho_3

The above table revealed that the F-calculated value for follow-up test effect is 47.593 and the F-critical value of 4.00 from F (1, 58, 0.05) i.e. degree of freedom 1 and 58 at 0.05 level of significance. Since F-calculated value is greater than the F-critical value, this led to the conclusion that there is a significant difference in the mean knowledge retention scores of students taught with Guided discovery and lecture teaching methods.

Table 4a; Mean post-test achievement and follow-up retention test scores of students taught with guided discovery method.

Test	Retention	Post-test	Follow-up test
Group	N	X	X
University	15	42.19	43.18
Coll. of Educ	15	41.92	42.98

Table 4a shows the mean retention scores of University and College of Education students taught with Guided discovery teaching method at post-test and follow-up test. The above analysis shows that Guided discovery teaching method is effective on improving knowledge retentionof tertiary students be it University or College of Education.

Table 4b; One way Analysis of Covariance (ANCOVA) for mean knowledge retention scores of university and college of education students taught with Guided discovery teaching method.

Source of variation	SS	df	MS	F-Cal	F-crit	Decision
Adjusted mean	20.300	1	20.300	0.178	4.00	Ho Accept.
Error	3192.056	28	144.002			
Total		29				

F-cal = 0.178

F-crit = F (df, ∝)

=F (1, 28, 0.05)

= 4.20

; F-cal< F-crit, Accept Ho_4

The above table revealed that F-calculated value for follow-up test effect is 0.178 and F-critical value of 4.20 from (1, 28, 0.05) i.e. degree of freedom 1 and 28 at 0.05 level of significance. Since the F-calculated value is lesser than the F-critical value, this led to the conclusion that there is no significant difference in the mean retention scores of the students. More so, no school interaction effect.

Discussions

The study revealed that Guided discovery method is more effective on the academic achievement and retention of chemistry students than the conventional lecture teaching method. This implies that guided discovery method is effective in the teaching and learning of chemistry. The finding further established that there is significant difference in the mean achievement scores of students taught with guided discovery and lecture teaching methods at post-test. This implies that the effectiveness of the teaching method is significant. One can therefore say that Guided discovery method of teaching can enhance students' academic achievement and retention of knowledge in chemistry. This is in line with the findings of Iwuji (2012) which revealed that guided discovery method of teaching improved the academic achievement and retention of knowledge in basic science concepts among junior secondary school students. Similarly, Chianson, Kurumeh and Obida (2010) study, showed that cooperative learning strategy which belongs to activity-based like guided discovery enhances retention of concepts of circle geometry. The similarities recorded in this study may be attributed to the effectiveness of the treatment (activity-based). This also proves the efficacy of the teaching strategy.

The study finally revealed that there is no interaction of type of school and teaching methods with the performance scores of the chemistry students from the university and college of education. This implies that school type did not affect the achievement and knowledge retention of the students while teaching method did.

Conclusion

There is significant difference in the mean achievement and retention scores of students taught with guided discovery. Guided discovery method is more effective on the academic achievement and knowledge retention of chemistry students than the conventional lecture teaching method. This implies that Guided discovery teaching method is effective in teaching and learning of chemistry. This is in agreement with the conclusion of Iwuji (2012) that the

teaching strategythat teachers employ in science teaching has significant effects on students' achievement and retention of the learned concepts. There is also no interaction of school type and teaching method. The effect of the teaching method has nothing to do with the school where it is applied.

Recommendations

The following recommendations were made based on the findings of this study;

1. Teacher education institutions should incorporate Guided discovery method in the relevant areas of their curriculum units and expose both pre-service and in –service teachers to the use of Guided discovery method to enhance teaching and learning.
2. Seminars and workshops should be organized at the Local Education Authorities, Education Zones, State and Federal Ministry of Education where teachers' curriculum planners and textbook authorities will be taught various ways of using Guided discovery teaching method.
3. Teachers should expose students to Guided discovery method since the study revealed that Guided discovery is natural to students and as such students develop the feeling of working in directive and interaction which always leads to a considerable degree of discovery, clarity and retention of concepts.

Reference

Abramson, J. (2018), Guided discovery lesson plan template. Retrieved from https://study.com/academydiscovery-lesson-plan-template.htmldate:20/2/18

Amadi, V. C (2014), some correlates in Students Achievement in SSCE Chemistry. *Journal of Academic Scholarship* 15 (2), 108-115.

Amadi, V.C & Acholonu, V.N (2017), Assessment of teachers' understanding of criterion related validity in secondary schools. *Journal of the Nigerian Academy of Education* 13 (2), 29-36.

Anyanwu, S. U, Izuagba, A.C, Obiefuna, C. A & Afurobi, A. O (2009), *Issues in curriculum implementation.* Owerri: cel-bez publishing co.

Bruno, P, Ongaro, A. & Frascer, I. (2007), Long-term retention of material taught and examined in chiropractic curricula: it's relevance to education and clinical practice. *The journal of Canadian chiropractic Association.* 51 (1), 14-18.

Chianson, Kurume &Obida (2010) Effects of cooperative learning strategy on students retention.

Dale, E. (1996) *Audio-visual methods in teaching*. New York: Dryden press.

Dorjiss, E. (2013). *Activity based teaching learning method.* Retrieved http://dorjias.biogspot.com.ng/2013/05/normalhtml.Date4/9/17.

Ebbinghaus, H (2000). Theory of knowledge and retention overtime retrieved

from:https://www.retrieve.com/biog.the-forgettingcurre.httml.date:20/2/18.

Iwuji, N.P (2012) Effects of activity-based teaching strategy on academic achievement and retention in basic science concepts among Junior Secondary School students. An un-published masters degree thesis presented to the school of post-graduate studies, Ahmadu Bello University Zaria.

Labush, N. (2014),*Constructivism and guided discovery method.*http://www.didax.com/articles/constructivism-and-guided-discovery-cfm:4/2/18.

MEST (2006).The guided discovery learning concept.Retrieved from: http://www.edutechwiki-unique.ch/en/guided-discovery.eh/123942

Mkpa, N. D, (2009), Teaching method and strategies in curriculum theory and practice.*Curriculum organization of Nigeria*. 2 (1) 104-115.

Okafor, T. C, Nwike, B. C & Chukwu G. (2009), The effect of Jigsaw instructional strategy to foster meaningful learning and interest in geometric construction. *African Research Review,* 7(3): 156-167.

Okoro, F (2010), The effect of Jigsaw instructional strategy and individualized methods of learning on students' achievement in biology. *International Journal Education Review* 14 (3), 361-384.

Uwameiye, R & Ogunbameru, M (2005), The effect of activity based method of teaching (guided discovery method) on students' performance in financial accounting. Retrieved:*www.itdl.org/journalnov.05article03.html:Date4/8/17*