



Effects of 5Es Teaching Cycle on Retention Ability among Secondary School Students of Varied Ability in Mole Concept, in Zaria Education Zone, Kaduna State

Binta A. Muhammad, Efe M. Omwihirem, Salisu Abubakar
Department of Chemistry,
Federal College of Education, P M B 1041, Zaria.

ABSTRACT

The study investigated the effects of the 5Es Teaching Cycle on Retention ability in Mole Concept among Secondary School Students of varied ability, in Zaria Education Zone, Kaduna State. It employed a Quasi-experimental pretest and posttest control group research design, consisting of two groups (Experimental and Control group). The experimental group was taught 5Es Teaching Cycle in Mole concept while the control group was taught using the conventional lecture method. The study sampled eighty-one (200) SS 2 chemistry students, from two secondary schools in the Zaria Education Zone drawn from a population of 1,154 students. The instrument developed and used to collate data for the research was the Mole Concept Retention Test (MCRT) with a reliability coefficient of 0.80. The findings of the study showed that science (Chemistry) students taught to 5E teaching cycle in the teaching and learning of mole concepts in all the ability levels retained higher than those in the control taught using conventional lecture method. On the issue of gender differences, the study revealed that male and female in all ability groups exposed to the 5E teaching cycle performed equally well and had also no difference in their retention ability. Based on the findings, it is hereby recommended among others that the State Government, institutions and professional bodies such as the National Teachers Institution, Science Teacher Association of Nigeria and National Union of Teachers, should organize seminars, workshops, in-service and re-training programmed for teachers on the effective use of Activity-based, students-centred teaching strategy that focus on constructivist teaching approach and others, in the learning of mole concepts in Chemistry.

INTRODUCTION

Science according to Isa (2018), embraces every attempt of humans to explore, analyze, interpret and manage the universe. It is dynamic and essentially concerned with the search and explanation of both regularities and irregularities in nature. It involves the quest for actions and reactions, causes and effects in the environment. The purpose of science is to transform the environment towards improving the general quality of life, thus making the world better. Formal science involves a systematic study

of natural phenomena and its study allows students to experience the richness and the excitement of the natural world as they engage in inquiry, critical thinking and the demonstration of skills. The scientific enterprise is challenging and innovative. It blends with technology which focuses on inventions and problem-solving. Consequently, the harmonious interplay of science, technology and society is the springboard for sustainable development. It equally facilitates and enhances industrial and technological progress among the people and within a nation.

ARTICLE INFO

Article History
Received: August, 2020
Received in revised form: January, 2021
Accepted: April, 2021
Published online: May, 2021

KEYWORDS

5Es Teaching Cycle, Retention Ability, Mole Concepts

*Corresponding author: Muhammad, B. A. ✉ amirabintafce@gmail.com ✉ Department of Chemistry, Federal College of Education, Zaria. © 2019 Faculty of Technology Education, ATBU Bauchi. All rights reserved



This consciousness stems from global agitations for literacy in science and technology (Isa, 2018).

Several studies have been conducted in and outside of Nigeria to investigate the causes of students' underachievement and poor retention ability in Chemistry and other science subjects and the most recurring factor in all the reports is the inefficient teaching strategy employed by secondary school teachers, which is the conventional teaching strategy (lecture method) (Muhammad, Omwirhiren & Salisu, 2019). Gökhan, (2016) advised that for effective teaching to occur, the teacher should get the learners involved as much as possible in activities that will enable them to develop the needed process skills and attitudes relevant to scientific life. A variety of teaching strategies have been advocated for use in science and mathematics classroom, ranging from a teacher-centred approach to more student-centred ones. Muhammad, *et al*, (2019) suggested the use of innovative strategy such as Cooperative/Collaborative, Demonstration Method and Guided Inquiry-Based Learning Strategy, Computer Assisted Strategy, 5E-Learning Cycle model and so on is recommended for the teaching of science and Mathematics.

The 5E teaching cycle according to (Bybee, 2009) of engage, explore, explain, elaborate and evaluate is an instructional model for designing a series of experimentally rich lessons that are conceptually linked and developmentally sequenced to support the ongoing progressive refinement in student understanding and retention as it develops over time. In this model, each step with "E" refers to help students' learning by the experience of linking prior knowledge to new concepts. It is seen that the 5Es learning model is especially effective in the elimination of alternative conceptions (misconceptions) (Ultay, & Calik, (2016). This is because; constructivist learning theory claims that learning is an interaction between new knowledge and preexisting knowledge and people construct their knowledge by using their existing knowledge (Bybee, Joseph, April, Pamela, Janet, Anne & Nancy, 2006). It requires the instruction of five elements according to Ibrahim (2015):

1. The first phase, **Engagement**; In the engagement phase, the teacher captures students' interest and makes them curious

about the topic and concepts to be learnt meaningfully. This phase provides an opportunity for the teacher to find out what students already know or think they know about the topic and concepts to be developed. It also allows the teacher to assess the student's current understandings as well as their misconceptions through the use of attention-grabbing demonstrations or discrepant events. These activities intend to introduce the purpose of the lesson while setting the stage for inquiry by creating cognitive dissension in the mind of the student.

2. The second phase, **Exploration**; in the exploration phase students interact with materials and ideas through classroom and small group discussions. This helps the students to acquire a common set of experiences so that they can compare results and ideas with their classmates. Students in this phase are given a chance to raise questions, develop hypotheses and work with each other as they collect evidence, record data and share observations. This time encourages students to build on common experiences through inquiry-based labs or teacher-based inquiries.
3. The third phase, **Explanation**; in the explanation phase students are provided with an opportunity to connect their prior experiences with current learning and to make conceptual sense of the main ideas. This phase also provides the opportunity for the introduction of formal language, scientific terms and content information that might make students' prior experiences easier to describe.
4. The fourth phase, **Elaboration**; the central purpose of this stage is for the teacher to reinforce the intended concepts (mole concept) by engaging the students in activities that will allow them to extend and apply the evidence to new and real-world situations. Students are encouraged to construct valid ideas about the phenomena being studied through modification of their prior conceptions to include the new knowledge that they have gained through their explorations. In the elaboration phase also students are provided with the opportunity to apply introduced concepts to new experiences.

*Corresponding author: Muhammad, B. A. ✉ amirabintafce@gmail.com ✉ Department of Chemistry, Federal College of Education, Zaria. © 2019 Faculty of Technology Education, ATBU Bauchi. All rights reserved



5. The final phase, the **evaluation** phase that is centrally placed in the model and takes place virtually in every phase of the 5E teaching cycle model provides a summative assessment of what students know (Bybee, 2009).

This 5-teaching cycle if properly implemented enhances meaningful learning as improve students retention in chemistry and other science-related subjects (Umahaba, 2016).

Retention of knowledge is a very important factor affecting the teaching and learning of science. Permanent and meaningful learning is the ultimate target of educational endeavour (Bunkure, 2012). According to Bichi (2002), understanding and retention are products of meaningful learning when teaching is effective and meaningful to the students. Hornby (2010) defined retention as the ability to remember things. Lawal (2009) viewed retention as the ability of the memory to store information that can be recalled sometime after exposure to series of instruction or training. Bunkure (2012) defined retention as the ability to retain and consequently remember things experienced or learned by an individual at a time. Retention takes place when learning is coded into memory. According to Bichi (2002), appropriate coding of incoming information provides the index that may be consulted so that retention takes place without an elaborate search in the memory lane. Bichi further stated that the nature of the material to be coded contributes to the level of retention. Several factors influence retention. Bichi (2002) reported that learning improves retention while things that lead to confusion or interference among learned materials, decrease the speed and efficiency of learning and accelerates forgetting. Retention, in other words, is the continued existence of what has been. Studies conducted by Isa, (2018) and Babasule (2018) revealed that students had poor retentive ability in organic and chemical equilibrium respectively. This study employed the use of the 5E teaching cycle to curtail the poor retentive memory of senior secondary schools in Zaria education zone Kaduna state, Nigeria.

There have been debates on students' performances in science and mathematics concerning gender, which has continued to be of interest and inconclusive (Stoet, & Geary, 2013;

Muhammad et al, 2019). Gender has been identified as one of the factors influencing students' retention in sciences at the senior secondary school level. Lakpini (2006) revealed that male students received more criticism from their teachers than their females' counterpart as such that affects their retention in sciences (chemistry).

Contrarily, Babasule (2018) found gender differences in favour of male students. Even though Ibrahim, (2015) and Muhammed, (2017), Muhammad, et al (2019) in their separate studies, reported that gender did not affect academic achievement and retention of students taught chemistry using innovative teaching strategy such as 5Es teaching cycle. However, some instructional strategies are gender bias while some are gender-friendly; the degree of gender-related differences in learning varies from one method of instruction to the other. In the light of these, this study was conducted to investigate the impact of 5Es teaching cycle among Chemistry students' of varied ability on academic performance and gender in Zaria Education Zone, Kaduna State.

Purpose of the Study

The purpose of this study is as follows:

1. Examine the retention ability of secondary school chemistry students of varied abilities in mole concepts after exposure to the 5E teaching cycle.
2. Determine whether there is any difference in retention ability between male and female secondary school students of varied abilities in mole concept after exposure to the 5E teaching cycle.

Research Questions

The following research questions are formulated to guide this study.

1. what is the difference in the retention ability of secondary school students of varied abilities levels taught mole concept using 5E teaching cycle and those taught same concepts using the conventional lecture method?
2. what is the difference in the retention ability between secondary school male and female students of varied abilities

*Corresponding author: Muhammad, B. A. ✉ amirabintaface@gmail.com ✉ Department of Chemistry, Federal College of Education, Zaria. © 2019 Faculty of Technology Education, ATBU Bauchi. All rights reserved



taught mole concept using 5E teaching cycle?

Research Hypotheses

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

Ho₁: There is no significant difference in the retention ability between secondary school chemistry students of varied abilities taught mole concept using 5E teaching cycle and those taught same concepts using the conventional lecture method.

Ho₂: There is no significant difference in retention ability between male and female secondary school students of varied abilities taught mole concept using the 5E teaching cycle

METHODOLOGY

The research employed a quasi-experimental-pretest and posttest control group design. The study involves control and experimental groups consisting of both male and female study subjects. A pre-test was administered to the groups, before the treatment, to determine the group equivalence. The experimental group was taught the Mole concept using 5Es teaching cycle for six weeks, while the control group was taught the same concept using the lecture method for six weeks. At the end of the treatment period, a posttest was administered to both groups of students to determine the effectiveness of the treatment in the Mole concept on senior secondary school chemistry students of varied ability.

The population of this study comprised all public co-educational Senior Secondary Schools (SS-II) Students offering Chemistry as a subject in the Zaria Education zone. The public coeducational schools are selected for use in this study because of their convenience, availability of infrastructure, population, readiness to assist the researcher when conducting research, gender equality among others. There are eleven senior secondary schools with a total of 1,154 students. 711 students are males and 443 students are females. 200 students were sampled out using the simple random sampling technique out of which (77 are in the experimental and 123 are in the control groups). One validated instrument labelled “Mole Concept Performance Test (MCRT)” was used to collect data for the study. MCRT had a reliability of 0.80 when subjected to Alpha Cronbach’s statistics.

RESULTS AND FINDINGS

The research hypotheses tested using the t-test at P≤ 0.05. The analysis was done with the aid of Statistical Packages for Social Sciences (SPSS version 20).

Ho₁: There is no significant difference in the retention ability between secondary school chemistry students of varied abilities taught mole concept using 5E teaching cycle and those taught same concepts using the conventional lecture method.

The result of Analysis of Covariance (ANCOVA) is as shown in Table 1;

Table 1: Analysis of Covariance (ANCOVA) of difference in the mean retention ability of Experimental and Control Groups.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Remark
Corrected Model	2038.180 ^a	4	509.545	8.566	.001	*S
Intercept	30374.167	1	30374.167	510.647	.001	*S
GROUP	1856.650	1	1856.650	31.214	.001	*S
SEX * GROUP	11.454	1	11.454	.193	.661	*NS
Error	11598.940	195	59.482			
Total	94600.000	200				
Corrected Total	13637.120	199				

NB: *S = Significance, *NS = Not significance

*Corresponding author: Muhammad, B. A. [✉ amirabintaface@gmail.com](mailto:amirabintaface@gmail.com) [✉](mailto:amirabintaface@gmail.com) Department of Chemistry, Federal College of Education, Zaria. © 2019 Faculty of Technology Education, ATBU Bauchi. All rights reserved



From Table 1, Analysis of Covariance (ANCOVA) statistics showed that a significant difference exists in the mean retention ability of SS II chemistry students of varied abilities taught with 5E teaching cycle and those taught with lecture method. The reasons being that the intercept P-value of 0.001 is less than the $P \leq 0.05$ alpha level of significance. The significant P-value for varied abilities was 0.001 and that of the treatment group was 0.001. The P-value of the treatment group was 0.001 which were all found to be lower than

the $P \leq 0.05$ alpha level of significance. Therefore, the null hypothesis which states that there is no significant difference in the retention ability between secondary school students of varied abilities taught mole concept using the 5E teaching cycle is hereby rejected.

Ho₂: There is no significant difference in the retention ability between male and female secondary school students of varied ability taught mole concept using the 5E teaching cycle.

Table 2: Analysis of Covariance (ANCOVA) of difference in the mean retention ability of male and female students in the Experimental Group

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Remark
Corrected Model	5935.964 ^a	6	989.327	55.434	.000	
Intercept	15448.210	1	15448.210	865.596	.000	
PRTEST	56.675	1	56.675	3.176	.079	
SEX	.279	1	.279	.016	.901	
ABILITY	4932.340	2	2466.170	138.185	.000	
SEX * ABILITY	8.792	2	4.396	.246	.782	
Error	1249.283	70	17.847			
Total	50725.000	77				
Corrected Total	7185.247	76				

Table 2 showed that there is no significant difference in the retention ability of male and female chemistry students taught mole concept using the 5E teaching cycle. This is simply because the P-value of 0.821 is greater than $P \leq 0.05$ alpha values. Therefore, the null hypothesis which states that there is no significant difference in the retention ability between male and female secondary school students of varied ability taught mole concept using the 5E teaching cycle is hereby retained.

DISCUSSIONS

This study investigated the influence of the 5E teaching cycle on the Retention ability of Students of varied abilities in Mole Concepts of Chemistry among Senior Secondary School in the Zaria Educational Zone. The data collected from the Post post-test administered were analyzed employing the Analysis of Covariance (ANCOVA) statistic at $P \leq 0.05$ levels of significance.

The finding in Table 1, which test the retention ability of students in the mole concept,

shows that a significant difference exists in the mean retention abilities of SS II chemistry students of varied abilities levels taught mole concept with 5E teaching cycle and those taught with lecture method. These findings agree with the earlier findings of Anaso (2008), Lakpini (2006), Bunkure (2012), Muhammad and Isa (2019) who found that students in the experimental group (5E teaching cycle) of varied ability levels had higher retention ability than the control group (Lecture) of varying ability levels. The suitability of the 5Es learning model as a means of promoting high order thinking skills and academic performance may be attributed to the nature of the instruction which is inquiry-based and student-centred and thus provides a wide range of activities for the students to control, take responsibility for their action in the process of learning and form their idea from already existing facts (Ibrahim, 2015).

The result of hypothesis 2 shows that at significant confidence of $P < 0.05$, there is no significant difference in the retention ability of students concerning gender, as the treatment with

*Corresponding author: Muhammad, B. A. ✉ amirabintaface@gmail.com ✉ Department of Chemistry, Federal College of Education, Zaria. © 2019 Faculty of Technology Education, ATBU Bauchi. All rights reserved



5Es was noticed to be gender friendly. This result supports the observation by Lakpini (2006), and Bunkure (2012) and Felicia and Peter (2013) that the learning cycle enhances students' achievement and it also favours both boys and girls, giving credence to the learning cycle as a gender-friendly and sensitive approach. This finding is in agreement with the report of Usman (2002), Bichi (2002), Ogunboyede (2003), Gandu (2006) who independently reported that male and female students perform the same in academic achievement when exposed to activity-based teaching method such as 5Es learning cycle.

CONCLUSION

From these findings, the following conclusions are drawn that 5Es teaching cycle has the potentiality for enhances higher-order thinking skills, promotes better students' retention in mole concepts and gender-friendly among students of varied ability. Therefore 5Es learning model is viable and has the potential of enhancing senior secondary school chemistry students' retention. This is therefore observed that the lecture method (conventional method of instruction) commonly used by teachers in secondary schools is not quite suitable for meaningful teaching and learning of science concept as it is not a student-centred approach.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made:

1. 5E Teaching cycle encourages better retention of learnt concepts and increased attitude of senior secondary school students towards it. It should therefore be used regularly in the teaching and learning situation particularly mole concept and other threshold concepts
2. The State government, institutions and professional bodies such as the National Teachers Institute (NTI), Science Teachers Association of Nigeria (STAN), Teachers' Registration Council of Nigeria (TRCN) and National Education Research Department Council (NERDC) should organize seminars, workshops, in-service and re-

training programme for teachers on the effective use of Activity-based, students centred teaching strategy that focuses on constructivist learning in the teaching of chemistry.

REFERENCES

- Abah, R. K. (2006). Attitudes towards Science: A Quantitative Synthesis. *Science Education* 106 (21), 547-567.
- Abdullahi, J. G. (2015). Effect of Computer-Assisted Instruction and Lecture Method on Retention and Academic Achievement among Senior Secondary Schools Students in Electrolysis concepts in Katsina State, Nigeria. Unpublished M.Ed thesis, Department of Science Education Ahmadu Bello University Zaria. 36-39
- Babasule, H. (2018). Effects of learning cycle on students' reflective thinking and academic performance in chemical equilibrium among senior secondary school students in Sabon Gari Local Government Area, Kaduna, State. Unpublished Med. Dissertation, Department of Science Education, A.B.U Zaria.
- Bichi, S. S. (2002). Effects of Problem Solving Strategy and Enriched Curriculum on Secondary Schools Students Achievement in Evolution Concept. Unpublished PhD Dissertation, A.B.U. Zaria.
- Biological Sciences Curriculum Study (BSCS). (2006). *BSCS Science: An Inquiry Approach*. Dubuque, IA: Kendall/Hunt Publishing Company.
- Bunkure, Y. I. (2012). Effect of a Constructivist Instructional Strategy on the Academic Achievement, Retention and Attitude to Physics among Secondary School Students of Different Ability Levels in Kano State, Nigeria. Unpublished PhD Dissertation, Department of Science Education, Ahmadu Bello University, Zaria.
- Bybee, R. W. (Ed) (2002). *Learning science and the science of learning*. Arlington, VA: NSTA Press.

*Corresponding author: Muhammad, B. A. ✉ amirabintaface@gmail.com ✉ Department of Chemistry, Federal College of Education, Zaria. © 2019 Faculty of Technology Education, ATBU Bauchi. All rights reserved



- Bybee, R., Taylor J., Gardner A., Scotter, P., Powell, J., Westbrook, A., & Landes, N., (2006). *The BSCS 5E Instructional Model: Origins, Effectiveness, and Applications*. Executive Summary, BSCS, Colorado Springs, CO.
- Çalik, M., Ayas, A., and Coll, R.K. (2010). Investigating the effectiveness of usage of different methods embedded with four-step constructivist teaching strategy. *Journal of Science Education and Technology*, 19(1), 32–48.
- Federal Republic of Nigeria (2013). National Policy on Education. Abuja: FME.
- Opara, F. & Waswa, P. (2013). Enhancing Students' Achievement in Chemistry through the Piagetian Model: The Learning Cycle. *International Journal for Cross-Disciplinary Subjects in Education (IJCDSE)*, 4(4), 23-25
- Gökhan, U. (2016). Effect of Learning Cycle Approach-based Science Teaching on Academic Achievement, Attitude, Motivation and Retention. *Universal Journal of Educational Research, Faculty of Education, Kastamonu University, Turkey*. 4(5): 1223-1230.
- Ibrahim, T.S. (2015). Impact of 5Es learning cycle on academic performance, Retention and The attitude of Biology Students with Varied Abilities, North-West Zone, Nigeria. Unpublished PhD. Thesis. Ahmadu Bello University Zaria
- Isa, Y. B. (2012). Effects of a Constructivist Instructional Strategy on the Academic Achievement, Retention and Attitude to Physics among Secondary School Students of Different Ability Levels in Kano, Nigeria. Unpublished M.ED Dissertation, Department of Science Education Ahmadu Bello University Zaria
- Isa, M.I. (2018). Effect of Jigsaw/IV Cooperative Learning Strategy on students' Perception, Retention and Academic Performance in Organic Chemistry in Zaria Education Zone, Kaduna State. Unpublished M.ED Dissertation, Department of Science Education Ahmadu Bello University Zaria
- Khairulanuar, S., Nazre, A.R., Sairabanu, O.K. & Norasikin, F. (2010). Effects of training method and gender on learning 2D/3D geometry. *Journal of Computers in Mathematics and Science Teaching*, 29(2), 175 - 188. Chesapeake, VA: AACE. Retrieved on the 15th April 2018, from <http://www.editlib.org/p/33188>
- Lakpini, M. A. (2006). Effects of a Conceptual Change Instructional Strategy on the Achievement, Retention and Attitude of Secondary School Biology Students with Varied Ability. An Unpublished PhD Dissertation at the Department of Education, Ahmadu Bello University, Zaria.
- Madu, B.C and Amaechi C.C.(2012). Effect of Five-Step Learning Cycle Model on Students' Understanding of Concepts Related To Elasticity. *Journal of Education and Practice*. 3(9).
- Mohammed N.N (2017). The Effect of Interactive Engagement Teaching Strategy on Academic Performance and Retention in Chemistry among Secondary School Students in Nasarawa State, Nigeria. Unpublished M.Ed. Dissertation Department of Science Education Ahmadu Bello University, Zaria.
- Muhammad, B. A; Omwirhiren E. M; Abubakar, S. (2019). Influence Of 5e-Teaching Cycle On Attitude, Retention And Academic Performance of Students with varied ability in Selected Secondary Schools in Zaria Education Zone, Kaduna State Nigeria
- National Research Council, (2007). Inquiry and the National Science Education Standards. Washington, DC: National Academy Press.
- O.' Brien T. (2010) 5E (1) . *Guidelines for Designing Research-informed Science Lesson Sequences*. NSTA Press. Arlington, Virginia.
- Olson, V. E. (2002). Gender differences and the effects of cooperative learning in college-level mathematics. Unpublished PhD thesis, Curtin University of Technology, Perth, Western Australia.

*Corresponding author: Muhammad, B. A. ✉ amirabintaface@gmail.com ✉ Department of Chemistry, Federal College of Education, Zaria. © 2019 Faculty of Technology Education, ATBU Bauchi. All rights reserved



- Tuna, A. and Kacar, A. (2013) The Effect Of 5e Learning Cycle Model In Teaching Trigonometry On Students' Academic Achievement And the Permanence of their Knowledge: International Journal on New Trends in Education and their Implications: 4 (1) Article: 07 ISSN 1309-6249. Copyright © International Journal on New Trends in Education and Their Implications / www.ijonte.org
- Ültay, N., and Çalik, M. (2016). A Comparison of Different Teaching Designs of Acids And Bases" Subject. *Eurasia Journal of Mathematics, Science & Technology Education.*, 12(1), 57-86.
- Umahaba R. E (2016). Impact of 5es Learning Model on Questioning Style Preference and Academic Performance among Secondary School Chemistry Students, Katsina Metropolis, Nigeria. Unpublished PhD (Science Education) Dissertation. Ahmadu Bello University Zaria, Nigeria.
- Vee, V. (2013). *Grouping Students by Ability Regains Favour in Classroom*, Chyl Centre for the New York Times.
- Yadigaroglua, M. and Demircioglu, G. (2012). The Effect Of Activities Based On 5Es Model on Grade 10 Students Understanding of the Gas Concept. *Procedia-Social and Behavioral Science.* 47, 634-637.