EFFECT OF VEE MAPPING STRATEGY ON SENIOR SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN CHEMISTRY IN IMO STATE NIGERIA

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Abstract
This study was carried out to determine the effect of vee mapping strategy on senior secondary school students' academic achievement in chemistry in Imo State, Nigeria. Two research questions and two null hypotheses were raised and formulated respectively. The study adopted a quasi-experimental research design The population for the study consisted of 3825 SSII chemistry students from the public secondary schools in Imo State in 2019/2020 session. The sample of the study was ninety seven (97) SS11 chemistry students comprising of 49 control groups and 48 experimental groups drawn from the population using purposive sampling technique. Two intact classes were used. The instrument for data collection was Chemistry Achievement Test (CAT) adapted and used in collecting data for the study. The instrument was validated and a reliability test carried out using Kuder-Richardson 20. This gave a reliability coefficient of 0.72. Mean and standard deviation was used to answer the research questions while Analysis of Covariance was used to test the null hypotheses at 0.05 level of significance. The results revealed that Vee mapping has relative effect on students' achievement in Chemistry and that there was a significant difference between the mean achievement scores of students taught chemistry using vee mapping teaching strategy and that strategy is superior to lecture method in enhancing students' achievement in Chemistry. Also, $_{female\ \ students}$ taught chemistry using vee mapping teaching strategy has equal achievement with their male counterpart and that there is no significant difference in mean achievement scores of male and female students taught chemistry using vee mapping. Based on the findings of the study, it was recommended among others that teachers should use vee mapping teaching strategy in teaching chemistry as it enhances students' academic achievement in Chemistry.

Keywords: Vee Mapping Teaching Strategy, Chemistry, Academic Achievement

Introduction

Chemistry is one of the core science subject taught at senior secondary schools level (SSS) in Nigeria. It is a science subject which deals with the study of the structure and composition of matter. Adejoba, Akinyemi, Adu, Olaobaju and Abuyomi (2012) explained that Chemistry is one of the three main branches of pure science that deals with the composition, properties and uses of matter. Operationally,

Chemistry is the study of matter, its structure, composition, transformation, uses and energy consequences of its behaviors' (Njoku, 2010). Chemistry is also one of the basic sciences (Biology, Chemistry, and Physics) that are essentially needed for a nation's technological development Njoku (as cited in Akwali, 2014). This is because many materials that are used in the society today are inventions resulting from practical works in Chemistry. There is hardly a branch of national economy which does not make use of the physical Chemistry techniques (Abe, 2013). For instance, Chemical analysis is important in controlling quality of raw materials, intermediate and finished products. Therefore, Chemistry as a subject offered at senior secondary school in Nigeria takes a central position in science and technology. It is a subject that studies the structure, interactions, transformations and the energy consequences of matter.

The objectives of Chemistry curriculum at the senior secondary school level include: to show Chemistry and its link with industry, everyday life benefits and hazards, and to provide a course which is complete for individuals not proceeding to higher education (Federal Ministry of Education FME, 2017). Therefore, Chemistry is to develop both the individual and the entire society. It is a necessary prerequisite and integral part of such professions as Medicine, Pharmacy, Dentistry, Home Economics, Food Science, Engineering to mention but a few. Chemistry education is required to meet up with increase in demand for science and technology by private and government establishments. Without effective Chemistry education, our nation will likely remain impoverished. This is because the natural resources which abound in Nigeria need to be harnessed, processed and converted to needed products for optimum use. Solid minerals such as coal, columbite, tin, iron ore, kaolin, lime stone, gold, uranium and agricultural produce like animal hides and skins, rubber, palm produce, groundnut, cassava and so on are underutilized (Adara, 2013). Chemistry education would be very essential for more effective utilization of these resources.

However, despite all the importance attached to chemistry as a key science subject, students' achievement in the subject has been unimpressively poor over the years. For instance, students' percentage pass with credit and above in external examination like West African Senior School Certificate Exam (WASSCE) in the years 2016, 2017, 2018, 2019 were 23%, 31%, 22.94% and 38.98% respectively (WAEC Annual Reports form 2016 – 2019). Many factors have been attributed to the observed poor performance in Chemistry by students. Some of these factors include teaching method used by Chemistry teachers, difficult nature of the topics/concepts, lack of equipment and instructional materials and so on (Ali, 2018; Adara, 2013). Students' poor performance in Chemistry for quite a long time now has resulted to inadequate number of students offering Chemistry oriented courses in tertiary educational institutions in Nigeria (Nzewi, 2010). Owing to the poor achievement of these students, they will be found wanting in producing these resources in the industries, society and everyday life.

The topics perceived to be difficult by students according to the WAEC Chief examiner (2019), are reaction time and rate, collision theory, gaseous state and gaseous laws, organic chemistry, structure and energy level of atom, qualitative analysis, quantitative analysis, rate of chemical reaction, chemical equation, non-metals and their compounds, thermochemistry, nuclear chemistry, and astronomical chemistry. Ali (2018) opined that the most important factor for effective learning to take place in science is an interesting instructional approach used. Njoku (2019) maintains that teachers are always under intense pressure to cover the curriculum and get students ready for external examinations. This makes teaching of Chemistry inadequate as special approach needed for the teaching of difficult chemistry concepts are often over looked. Learners therefore find the subject irrelevant to their daily experience and survival needs in their sociocultural and economic environment. Agbi (2006) also attributed students' poor performances in Chemistry to poor instructional approaches involving excessive teacher-talk, copying of notes, rote learning as encouraged by lecture method of instruction. Poor instructional approach is therefore recognized as a major contributor to poor achievement in Chemistry. Inaddition, Ifeakor (2015) attributed the low achievement of students in secondary school chemistry to teachers' non-utilization of appropriate teacher strategies instead most chemistry teachers use lecture teaching methods like lecture teaching method (LTM). Lecture teaching methods which also involve rote learning and text-book reading do not encourage students' activities such as group discussion, manipulating of objects, experimentation and creative thinking which are necessary for real science learning. Adesoji (2008) reported that shifting and going beyond the lecture teaching approaches implies adopting the innovative approaches to teaching and learning such as Vee-mapping. Vee-mapping is one way of making laboratory work more meaningful. Vee-maps concentrate on students' attention on the focus question, the event to be observed, and direct students to interpret results in terms of their prior knowledge. This process assists students to obtain on overall view of the laboratory exercise and to see how theory is linked to experimental work (Chauhan, 2009).

Vee mapping is a teaching approach where students use a V-shaped map to represent key elements (ideas) that are contained in the structure of knowledge. The key elements usually referred to as the Vee heuristics form the point of focus in knowledge creation in the objects or events that learners observe Gowin (as cited in Chauhan, 2009). The Vee map has two sides. The left hand side represents the theory and is referred to as the conceptual side. It outlines the philosophy, theories, principles and concepts that guide learners in selecting or constructing objects or events to be observed in the learning process. The right hand side represents the methodology, often referred to as methodological side which highlights the knowledge and value claims as well as data recording and transforming procedures. Placed in the middle of the Vee map is the focus question and events or objects to be observed in the learning process (Chauhan, 2009).

The central idea in using a Vee map is that every element shown is interdependent with every other element on the Vee. The fundamental assumption is that knowledge is not absolute, but rather it is dependent upon the concepts, theories and methodologies by which we view the world. This assumption is supported by several views of epistemology. Vee maps foster interplay between conceptual and methodological elements and the resultant knowledge or value claims. The knowledge claims are integrated into an individual's cognitive meaning frameworks. Novak (as cited in Okeke, 2017) carried out a study on the use of vee mapping in learning Physics at high school level. The findings of the study revealed that most students were relatively successful in using the vee maps and that performance improved. This can be attributed to the fact that vee-mapping helps the students to sort out events or objects under study for better academic achievement. Achievement is a term used to indicate the degree of success attained in some general or specific area. Obodo (2010) stated that achievement is the extent or degree of attainment of students in tasks, courses, or programs to which they were sufficiently exposed. Baird (2009) asserted that achievement is quantified by a measure of the student's academic standing in relation to those of other students of his age. Students' achievement in secondary schools subjects were obtains by a score or mark on a test or examination.

Achievement in Chemistry may be influenced by gender. Gender is defined as a socially ascribed attributes which differentiates feminine from masculine (Okeke, 2017). Gender disparity in education is a worldwide phenomenon. The issue of closing gender gap in sciences, mathematics and vocational subjects has remained elusive. Adara (2013) stated that female students rarely enroll into science related courses as a result of teachers teaching methods which change their interests and their achievements. However, Adara (2013) asserted that the consequences of gender stereotyping cut across social, economic, political and educational development especially in the area of science and technology. Nwosu (2011) indicated that male students perform slightly better than female counterparts in science related tasks. The researcher opined that even though male student may perform slightly better than female cognitive ability, type of exposure among other factors may relate more strongly on achievement level in science than gender. However, Deighton (2010) reported that there is no significant difference between the male and females' students in academic achievement. Anaekwe (2017) found out that there was significant difference in the mean achievement scores of male and female student in chemistry in favour of the male students; similarly Ifeakor (2015) found out that there are significant differences in the mean achievement scores of male and females in favour of the males.

Despite the fact that many studies have been carried out to ameliorate the bad situation as regards to students' academic achievement and gender differences. Many instructional approaches have been proffered by psychologists like Brunner, Piaget, Gagne, and Ausubel to improve achievement in Chemistry and other sciences. Ausubel (2003) and Njoku (2010) strongly submitted that the instructional approach

adopted by teachers in teaching Chemistry is to a large extent responsible for the observed consistent poor achievement in Chemistry. It has been observed that many chemistry teachers today employ the expository teaching methods like lecture method and this seems not to be effective in fostering learning and enhancing students' achievement. The lecture teaching methods lack student's cooperation and as such results in students poor achievement in the subject. Adequate students' cooperation and interactions are required for learning and transfer of learning in Chemistry concepts, which are mainly difficult, and abstract. Such cooperation and interaction may be found in innovative teaching strategies like the vee mapping teaching strategy. Hence, the researcher wants to determine whether the use of an innovative teaching strategy like vee mapping teaching strategy would improve the academic achievement of students in Chemistry in secondary schools. Hence, this study investigated the effect of vee mapping strategy on senior secondary school students' academic achievement in chemistry in Imo State, Nigeria?

The following research questions guided the study:

1. What is the effect of Vee mapping strategy on senior secondary school students' academic achievement in chemistry?
2. What is the interactive effect of Vee mapping strategy and gender on senior secondary school students' academic achievement in chemistry?

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

1. There is no significant effect of Vee mapping strategy on senior secondary school students' academic achievement in chemistry.
2. There is no significant interactive effect of Vee mapping strategy and gender on senior secondary school students' academic achievement in chemistry.

Methodology

This study adopted a non-equivalent pretest-posttest control group design of quasi-experimental design. This design was appropriate because it utilized the non-randomized pretest-posttest control group design involving two intact classes of one experimental groups and one control group since it is impossible to randomize the subjects. The study was carried out in Imo State. The population of the study consisted of 3825 SSII chemistry students from the public secondary schools in Imo State in 2019/2020 session. (Source: SEMB, 2019). Sample size of the study comprised ninety-seven (97) SS11 chemistry students drawn from two secondary schools used for the study. The two secondary schools were drawn out from 312 secondary schools that made up the population of study using purposive sampling technique. The two groups used in the study are Group I Vee mapping teaching strategy with the total sample of 48 students (experimental group) and Group II: Lecture teaching method with a sample of 49 students (control group). The experimental group consisted a total number of 24 males and 24 females students and control group was made up of 24 males and 25 females SS II students' based on using two intact classes in each case.

The reason for choosing SSII students is that they are prospective candidates for public examinations such as SSCE, WASSCE, UTME, among others and given the public outcry of mass failures in public examination, it is expected that the use of vee mapping teaching strategy can inculcate in the students the attitude, knowledge and skills for better academic achievement.

The instrument for data collection was Chemistry Achievement Test (CAT). To ensure face and content validity, the instrument was given to three experts along with the table of specification and purpose of the study, one from chemistry education and two experts in Measurement and Evaluation, Department of science Education, Michael Okpara University of Agriculture, Umudike. Errors detected were corrected before the final production of the instrument.

The reliability coefficient of the Chemistry Achievement Test was determined by administering the instrument to SSII students (50 students from Ibeku High Secondary School, Umuahia, Abia State). Data obtained was analyse using Kuder-Richardson 20 which yield a correlation coefficient of 0.72.

The data collected was analyzed using mean and standard deviation to answer the research questions, while analysis of covariance (ANCOVA) at 0.05 level of significance was used to test the null hypotheses.

Results

Research Question One: What is the effect of Vee mapping strategy on senior secondary school students' academic achievement in chemistry?

Table 1: Mean Achievement Scores of Students Taught Chemistry using Vee Mapping and Lecture Method.

Instructional strategy	N	Pre-test Mean	SD	Post-test Mean	SD	Mean gain
Vee mapping	48	41.28	10.13	71.26	13.69	29.98
Lecture method	49	41.89	11.91	53.38	10.47	11.49

Result in Table 1 indicated that the pre-test mean score of students taught with vee mapping and lecture method were 41.28 and 41.89 respectively, indicating that pre-test mean is below average in either groups in Chemistry before experimentation. However, that the students taught using the vee mapping teaching strategy had a post-test mean score of 71.26 with a standard deviation of 13.69, while the students taught using the lecture method had a post-test mean score of 53.38. The 29.98 against 11.49 mean gain scores of the two groups indicate that students' vee mapping strategy performed extremely better than students taught with lecture method.

Hypothesis One: There is no significant effect of Vee mapping strategy on senior secondary school students' academic achievement in chemistry.

Table 2: Analysis of Covariance (ANCOVA) on Effect of Vee Mapping Strategy on Senior Secondary School Students' Academic Achievement in Chemistry

Source of variation	Sum of Squares	Df	Mean Square	F	p-value.	Decision
Corrected Model	10959.803[a]	2	5479.902	45.871	.000	
Intercept	9519.316	1	9519.316	79.684	.000	
PRETEST	2967.443	1	2967.443	24.840	.000	S
GROUP	9984.920	1	9984.920	83.581	.000	
Error	11229.522	94	119.463			
Total	410926.000	97				
Corrected Total	4101.911	96				

a. R Squared = .486 (Adjusted R Squared = .475), S = Significant

Result of data analysis in Table 2 showed that the probability value associated with the calculated value of F (83.58) is 0.000. Since this value (0.000) is less than the 0.05 alpha when tested at 0.05 level of significance, the null hypothesis is rejected. Hence, vee mapping strategy has significant effect on senior secondary school students' academic achievement in chemistry.

Research Question Two: What is the interactive effect of Vee mapping strategy and gender on senior secondary school students' academic achievement in chemistry?

Table 3: The Interaction Effects of Vee Mapping Strategy and Gender on Senior Secondary School Students' Academic Achievement in Chemistry

Gender	Groups	Mean	SD	N
Male	Vee Mapping	56.882	21.374	24
	Control	42.042	16.905	25
Pooled mean	Total	49.462	19.140	49
Female	Vee Mapping	50.786	13.102	24
	Control	42.222	16.254	24
Pooled mean	Total	46.504	14.678	48
Gender	Male	49.462	19.140	49
Interaction effect	Female	46.504	14.678	48
	Total	47.983	16.909	97

N= 97

Result in Table 3 showed that male students taught with vee mapping instructional strategy had more mean score than the students taught with lecture method as indicated by the mean score of 56.882 and 42.042 respectively, female students taught with vee mapping instructional strategy had more mean score than the female students taught with lecture method as indicated by the mean level of 50.786 and 42.222. However, the interaction effects of Vee mapping strategy and gender on senior secondary school students' academic achievement in chemistry favoured both male and female students as indicated by pooled mean of 49.462 male and 46.504 female.

Hypothesis Two: There is no significant interactive effect of Vee mapping strategy and gender on senior secondary school students' academic achievement in chemistry.

Table 4: Analysis of Covariance on interactive effect of Vee mapping strategy and gender on senior secondary school students' academic achievement in chemistry

Source	Type III Sum of Squares	Df	Mean Square	F	P. value
Corrected Model	6934.503[a]	3	2311.501	133.754	.000
Intercept	1214.144	1	1214.144	52.522	.000
Pretest	6211.312	1	6211.312	421.021	.000
Group	442.254	2	221.127	5.527	.010
Gender	243.650	1	243.650	13.144	.000
Strategy * Gender	54.271	1	61.245	2.154	.132
Error	2127.561	93	22.877		
Total	20586.384	97			
Corrected Total	10293.192	96			

From Table 4 it could be observed that the Probability (P)-value associated with F calculated value of 2.154 is 0.132. Since this P-value is greater than 0.05 alpha, the null hypothesis which stated that there is no significant interactive effect of Vee mapping strategy and gender on senior secondary school students' academic achievement in chemistry is thereby upheld. It implies that male and female students taught chemistry using vee mapping strategy are not significantly different in their academic performance. This also implied that the gender of the students did not actually combine with the strategy to influence their achievement in Chemistry rather, the increase in the students' achievement is not connected with the gender of the students but based on the vee mapping strategy used.

Discussion of the findings

The finding of the study revealed that students taught using vee mapping teaching strategy performed extremely better than students taught with lecture method. The corresponding hypothes affirmed that vee mapping strategy has significant effect on senior secondary school students' academic achievement in chemistry. This findings is in line with the finding of Okeke (2017) who revealed that vee-mapping helps the students to sort out events or objects under study, key questions being addressed, major claims derived from the records or transformed records and the consistency between concepts, principles, records, events or objects and the stated claims.

The finding of study showed that the interaction effects of Vee mapping strategy and gender on senior secondary school students' academic achievement in chemistry favoured both male and female students as indicated by pooled mean of 49.462 male and 46.504 female. The corresponding hypothesis affirmed that male and female

students taught chemistry using vee mapping strategy are not significantly different in their academic performance. This also implied that the gender of the students did not actually combine with the strategy to influence their achievement in Chemistry rather, the increase in the students' achievement is not connected with the gender of the students but based on the vee mapping strategy used. The finding is in line with the finding of Nwachukwu (2018) who revealed that there is no significant relationship achievement in interest and cognitive achievement of female secondary school students exposed to cooperative learning Chemistry concepts.

Conclusion

This study examined effect of vee mapping strategy on senior secondary school students' academic achievement in chemistry in Imo State, Nigeria. Based on the findings, the researchers concluded that students taught using vee mapping instructional strategy performed extremely better than students taught with lecture method, that there is significant effect of Vee mapping strategy on senior secondary school students' academic achievement in chemistry. This implies that Vee mapping teaching strategy positively enhanced senior secondary school students' academic achievement in Chemistry in the sampled schools in Imo State. However, the significant effect of the treatment (Vee Mapping Strategy) on the respondents' achievement has no influence on their gender.

Recommendations

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

1. Teachers should use vee mapping teaching strategy in teaching chemistry as it enhance both male and female students Academic Achievement in Chemistry.
2. Chemistry Subjects teachers should be trained on the use of vee mapping teaching strategy for better academic achievement in Chemistry.
3. Government and school owners should provide enabling environment and learning facilities to the teachers so as to facilitate optimal performance of students using vee mapping strategy.

References

Abe, E.A. (2013). The effects of simulation techniques on students achievement in English Language. *The Turkish Online Journal of Educational Technology – TOJET July 2003. ISSN: 1303-6521 Vol. 6, Issue 3, Article 11.*

Adara, O.A. (2013). Environmental education in formal and informal sector: problems and prospects.1st National Conference on Environmental Education proceeding. NCF/WWF, 20-24.

Adejoba, O.R. Akinyemi, O. Adu A.O. Olaobaju & Abuyomi, T.O (2012). Environmental education: Forestry awareness in secondary schools in Ibadan Oyo State. 43rd STAN Conference Proceeding 284-290.

Adesoji, F.A. (2008). Managing students attitude towards science through problem solving instructional strategy. Anthropologist 10(1) 21-24.

Agbi, A.I. (2006). Effects of interaction of teaching methods and study habits on students achievement and interest in chemistry "*Unpublished Ph.D Thesis*". Nsukka University of Nigeria.

Akwali, P.C. (2014).Development and Validation of a Scale for Assessing Students' Motivation in the Learning of Chemistry. *Unpublished (M.Ed) Thesis,* University of Nigeria, Nsukka.

Ali, A. (2018). Conducting Research in Education and Social Sciences: Tashiwa Networks. Nigeria.

Anaekwe, A. F. (2017). The Effects of Metacognitive Knowledge on the Pre-service Teachers Participation in the Asynchronous Online Forum. *Educational Technology and Society, 11 (3), 1-12.*

Ausubel, D. P. (2003). Educational Psychology: A Cognitive View. New York: Holt, Ausubel, D. P., Novak, J. D. and Hanesian, H. (2008). Educational Psychology: Retrieved 3- 1, 2007, from http://www.seasite.niu.edu/Talalog/Talalog/Teachers-page/Language

Baird, J. (2009). Self-regulated teaching for self –regulated learning. Paper presented at the meeting of the Eigth European Conference for Research on Learning and Instruction. Goteborg, Sweden.

Chauhan, S.S. (2009). *Innovations in Teaching Learning Process*. New Delhi: Vikas publishing House PVT ltd.125-130.

Deighton, L.C. (2010). The Encyclopedia of Education Vol.4 U.S.A Macmillan coy and The Free Press**.**

Federal Ministry of Education (2017). National Curriculum for Senior Secondary School. Vol.3 Lagos F.M.E.

Ifeakor, A.C. (2015). Evaluation of commercially produced computer assisted instruction package for teaching secondary school chemistry. An *Unpublished doctorate thesis* Nsukka: University of Nigeria.

Njoku, Z.C. (2010). Effects of practical work under different sex grouping on Students skill acquisition and interest in chemistry practical activities. *Unpublished Ph.D thesis*. Nsukka: University of Nigeria.

Njoku, Z.C. (2019). Comparison of students achievement in the three categories of questions in SSCE practical chemistry examination *JSTAN* 42 (1&2) 67-72.
Nwachukwu, S.N. (2018). Clarify With Vee Maps: A Tool for Students and Teachers alike. The Science teacher, 58,45-49.
Nwosu, S. N. (2011). Effects of gender sensitization of science teachers on gender Gap In science achievement and interest among Students. *An Unpublished Ph.D Thesis*. Nsukka: University of Nigeria.
Nzewi, M.U. (2010). The Nigerian woman as environmental managers. 42nd STAN Annual Conference Proceedings 268-271.
Obodo, G.C. (2010). The different effects of three teaching methods on the performance of JSS students in some algebraic concepts. *Unpublished Ph.D Thesis*. Nsukka: University of Nigeria.
Okeke, O. J. (2017). Effect of vee mapping teaching strategy on students interest, retention and achievement in senior secondary school Biology. *Unpublished Ph.D Thesis*. Nsukka: University of Nigeria.
Secondary Education Management Board (2019). Students' population retrieved from Research and statistics unit, Owerri Imo State
WAEC Annual Chief Examiner Reports form (2016 – 2019).West African Senior School Certificate Examination.