

## EFFECTS OF CONCEPT MAPS AND VEE DIAGRAMS ON STUDENTS' ACHIEVEMENT AND RETENTION IN EQUATIONS OF MOTION IN NASARAWA NORTH, NIGERIA

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### Abstract

The study investigated the Effects of Concept Maps and Vee Diagrams on Students' Achievement and retention in equations of motion in Nasarawa North, Nigeria. Quasi experimental research design was used for this study. The population of the study comprised 2824 SS II Physics students (1521 males and 1303 females) in North Senatorial District, Nasarawa State. Purposive and simple random sampling techniques were used in selecting three schools for the study. The sample for the study is made up 151 SS II students in Nasarawa State South Senatorial District schools. Two research questions guided the study and two null hypotheses were tested at 0.05 level of significance. The instrument used for data collection was Equation of Motion Achievement Test (EMAT). Kuder – Richardson 21 (KR – 21) was used to determine the internal consistency of EMAT and  $r = 0.78$  was obtained as the coefficient of reliability. Descriptive statistics of mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the

hypotheses at 0.05 level of significance. Bonferroni Multiple Comparisons was used to determine the direction of the difference between the groups. The result of this study reveals the following: Students taught equations of motions with Concept Maps achieved higher than those taught using Vee Diagrams. ( $F = 7.196$ ;  $P = 0.001 < \alpha = 0.05$ ). Students taught equations of motion using Concept Maps and Vee Diagrams and Lecture Method showed retention at par ( $F = 20.811$ ;  $P = 0.000 < \alpha = 0.05$ ). Based on the findings of this study, it was recommended that: Since Concept Maps and Vee Diagrams are found to be an effective strategy for improving students' achievement, teachers should be endeavour to use Concept Maps and Vee Diagrams in the teaching of Equations of motion. Seminars and workshops should be organized by STAN in Physics to train teachers on the use of Concept Maps and Vee Diagrams to help enhance the achievement of students in Physics concepts.

**Keywords:** Achievement, Concept Mapping, Equation of Motion, Retention and Vee Diagrams

## Introduction

Physics is mainly the study of matter, motion and energy. Traditionally, it consists of concepts such as mechanics, electricity, electromagnetism, optics and thermodynamics. However, it has expanded to include quantum mechanics, relativity and nuclear Physics (Eric, 2015). The knowledge of Physics has been useful in the field of medicine, industry and engineering. In Nigeria, Physics is taught at secondary school level in order to achieve the following objectives: to promote basic literacy in Physics for functional living in the society, to acquire basic concepts and principles of Physics as a presentation for further studies, to acquire essential scientific skills and attitude as a preparation for the technological application of Physics and to stimulate and enhance creativity (STAN, 2014). Therefore, the teaching of Physics at secondary school level lays the foundation for the application of science and technology for the benefit of the society. Physics as one of the science subjects taught at secondary school level offers the student an opportunity to think critically, reason analytically and to acquire the spirit of enquiry. Gambari, Yusuf and Thomas (2015) reported that Physics education is designed to train the students to acquire proper understanding of the basic principles as well as their applications. Therefore, Physics is an important science subject that makes immense academic demands on students in its learning as well as its teaching. It is an important discipline and a fundamental ingredient of technology. This is in line with the view of Adeyemo and Babajide (2014), who reported that both developed and developing countries such as

USA and Nigeria respectively have realized the importance of Physics in national development.

The learning of Physics is one of the fields of knowledge that underlies the physical universe and applies constantly to people's everyday lives (Zachariah, Gbatala & Frayer, 2014). Thus, for national development in technology, knowledge of basic concept and principles in Physics are indispensable. The importance of Physics to technology development has earned it a place as a core subject for science students. Also, it is one of the major requirements for entry into science and engineering programmes in higher institutions in Nigeria (FGN, 2014). Unfortunately, despite the importance and relevance of Physics, indices from various examination bodies, such as the West African Examination Council (WAEC), have shown a consistent trend of low enrolment and poor achievement of students" in Physics examinations. For instance, the research by Erinsho and Onabanjo (2013) revealed that consistently for five years, on the average, less than 30% of the total students who registered for secondary school certificate examination (SSCE) entered for Physics.

In Nigeria, the evidence of low enrolment and massive failure in public examinations (Secondary School Certificate Examination) in Physics is indicative that poor achievements have consistently been reported in external examinations. However, physics has been characterized by poor achievement in School Certificate Examinations. These reports were further

buttressed by the statistics of students' achievement in Senior School Certificate Examination (SSCE).

**Table 1.1: Students' Results in Physics in SSCE (2015 – 2020) for Secondary Schools in Nasarawa North, Nasarawa State, Nigeria**

S/ N	Ye ar	Tot al No. Ent ry	Total Distinc tion (%)	Total Cred its (%)	Total Passe s (%)	Total Failur es (%)
1.	20 15	231	12(5.2)	23(10 .0)	35(15 .0)	161(6 9.8)
2.	20 16	266	11(4.0)	33(12 .4)	43(16 .0)	180(6 7.6)
3.	20 17	267	16(6.0)	17(6. 2)	53(20 .0)	181(6 7.8)
4.	20 18	353	21(6.0)	49(14 .0)	64(18 .0)	219(6 2.0)
5.	20 19	249	16(6.3)	18(7. 4)	52(21 .0)	163(6 5.3)
6.	20 20	283	14(5.0)	16(5. 6)	65(23 .0)	188(6 6.4)

Table 1.1 indicates the overall achievement of students in Senior School Certificate Examination in Physics for six consecutive years (2015 – 2020). The results show that students performed poorly in Physics in SSCE. According to the reports of SSCE Chief Examiners during the period, equations of motion is one of the students' difficult areas. Several factors contribute to students' poor performance. This analysis shows poor trend of performance or low achievement in Physics for the past six years. Heil (2015) attributed the difficulty primarily to abstract nature of the content. Munyaradzi (2014) observed that students are exposed to the Physics contents but they are not able to apply the facts to novel and related situation. Different instructional

techniques could improve students' acquisition of knowledge in Physics (Guewwe, 2014). Researchers such Obafemi and Onwioduokit (2013) opined that one of the observed reasons for the declining students' achievement in Physics is the passive teaching methods or strategies that are widely employed by many teachers in the Physics classrooms.

The traditional Physics instruction, which is normally conducted based on a theoretical basis, together with the teacher-centred approach, may also contribute to the observed low students' achievement in Physics. This undesirable issue may be due to the difficulty of students' understanding of the underlining concepts, due to the mere absence of an appropriate learning strategy for impacting knowledge of Physics concepts (Yusuf, Gambari & Olumori, 2012). Some researchers Gambari, Yusuf and Thomas (2015) and Gambari, Emmanuel and Ikusanu (2015) have indicated that teachers use inappropriate teaching methods and strategies in teaching science students which among other factors have contributed to gradual poor students' performance in Physics. The problem of devising an effective teaching technique has preoccupied science educators for many centuries (Zepure, 2018). They strived for the promotion of meaningful learning rather than learning by rote. Two of such techniques that may promote better comprehension for meaningful learning in Physics are concept maps and vee diagrams.

Concept mapping and Vee diagrams instructional strategies are associated with meaningful and mastery learning (Osisioma,

2015; Otor, 2016; Onyejekwe, Uchendu & Nmon 2018). They enable students to identify the major concepts and relate them to the concepts in their existing knowledge structure (Guewwe, 2014). The learner therefore plays an active role in knowledge construction, which leads to meaningful learning. Concept mapping is a teaching approach where learners organize concepts and relationships between them in a hierarchical manner from more inclusive concepts to more specific and less inclusive concepts (Eria, 2015; Guewwe, Hill, Carvaho, Peterside & Smith, 2014). While using this teaching/ learning approach, students identify major and more inclusive concepts at the top followed by the minor and more specific concepts at the bottom. The major and more inclusive concepts are referred to as super-ordinate concepts while minor and more specific concepts are called subordinate concepts. The super-ordinate and subordinate concepts are placed in ovals and then connected using suitable linking words (Okeke, 2014; Krishnaratue, Cffey, Hoffman, Canas & Ford, 2014).

Vee diagram is another instructional strategy 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 6 objects or events that learners observe (Gowin, 1977). The Vee diagram 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. The right side highlights the knowledge and value claims as well as data recording and transforming procedures. Placed in the middle of the Vee diagram is the focus question and events or objects to be observed in the learning process. The central idea in using a Vee diagram is that every element shown is interdependent with every other element on the Vee (Mehmet, 2017).

The fundamental assumption is that knowledge is not absolute, but rather it is dependent upon the concepts, theories and methodologies by which the world is viewed. This assumption is supported by several views of epistemology (Toulmin, 1953). Vee diagrams foster interplay between conceptual and methodological elements and the resultant knowledge or value claims (Mehmet & Erkol, 2019). The knowledge claims are integrated into an individual's cognitive meaning frameworks. Novak (1983) and his team carried out a study on the use of Vee diagram in learning of students at the high school level. The study was done simultaneously with that of concept mapping. The findings of the study revealed that most students were relatively successful in using the Vee diagrams and the performance improved. This can be attributed to the fact that Vee diagrams 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. Therefore, concept mapping and

Vee diagrams are tools that would aid pedagogy that derives from recent advances in educational theory (Novak & Gowin, 2005). The advances in other fields require the professional teachers to know the theory underlying the tools in order to employ them most successfully. Concept maps and Vee diagrams strategies usage is likely to motivate students and thus improve on their achievement (Nikita, Browuse & Surzette, 2015).

Achievement is the level of success or performance students attained after test has been administered to them. According to Obi and Okeke (2016), academic achievement refers to performance on a task with measures including comprehension, quality and accuracy of answers of tests, quality and accuracy of problem-solving, frequency and quantity of desired outcome, time or rate to solution, time on task, level reasoning and critical thinking, creativity, retention and recall, and transfer of tasks. Student's achievement is an essential factor in quality education. Moreover, Ra'ed and Khedr (2013) found that the learner's experiences and situations, the quality of schools and educators, and many other factors affect academic achievement. Despite all these, academic achievement still remains an essential factor in quality education and needs urgent attention. Osborne (2016) noted that the use of inappropriate teacher centered strategies like lecture method accounts for the highest poor performance of science students. These researchers remarked that most teachers in Nigerian schools still believe that the most effective means of communicating to students (Physics students inclusive) is

through the conventional "talk and chalk" teaching or learning strategy.

According to Soares and Valadares (2016), conventional teaching strategy involves the teacher presenting a verbal discourse mainly on a particular subject, theme or concept to the learners. This strategy of teaching entails delivering preplanned lessons to the students with little or no instructional aid that involves students' activity. In Nigeria, conventional teaching strategy indicates a strategy that is formal and has been in use for long. That is why this strategy is usually nicknamed 'traditional teaching strategy'. This strategy is one of the easiest to deliver and that may be why many teachers often use it without recourse to constructive teaching strategies that can promote the acquisition of scientific understanding and achievement. Closely related to achievement is retention. This is because if knowledge is retained, then it can be recalled when needed.

Retention is the act of transferring information from short term memory to long term memory. Retention comes in before recall. It is recall that reveals how much knowledge the students have retained after the teaching and learning (Smith, 2015). Retention can be the extent to which one can retrieve information from long term memory. The success of retrieval depends upon effective encoding (meaningful learning) that involves making associations with existing knowledge that can facilitate future retrieval among students irrespective of their gender (Richard, 2015). Meaningful learning could only be adjudged to have taken place by the demonstration of such a

recall. The perceived difficulty of physics by learners is linked primarily to the fact the concepts taught are not retained by the learners (Uche & Alberto, 2016). Retention creates a welcoming and supportive environment, clearly communicating grading policies and provide frequent feedback on students learning by encouraging them to engage in scientific method, bringing real world relevant into the classroom and highlighting careers in sciences. This study examined how learning has taken place and retained over a period of time and remembered when taught equation of motion.

So far, the conventional methods employed in teaching physics have not improved students' achievement and motivation in the subject to a considerable extent. As a result, developing better strategies of teaching physics has been and becoming one of the core issues that scholars deal with in physics education. There are many alternative methods and strategies that could help students develop interest in science and achieve better. This study seeks to try two such strategies – Concept maps and Vee diagrams Learning Strategies to see their effects on students' achievement and retention in in equations of motion in Nasarawa State, Nigeria.

### Research Questions

The following questions guided the study.

1. What are the mean achievement scores of students taught equations of motion using concept maps, vee diagrams and the lecture method?
2. What are the mean retention scores of students taught equations of

motion using concept maps, vee – diagrams and the lecture method?

### Hypotheses

This research study was guided by the following Null hypotheses ( $H_0$ ) tested at 0.05 level of significance.

**H<sub>01</sub>:** There is no significant difference in the mean achievement scores of students taught equations of motion using concept maps, vee diagrams and lecture method.

**H<sub>02</sub>:** There is no significant difference in the mean retention scores of Students taught equations of motion using concept maps, vee diagrams and lecture method.

### Methodology

Quasi experimental research design was used for this study. The population of the study comprised 2824 SS II Physics students (1521 males and 1303 females) in North Senatorial District, Nasarawa State. Purposive and simple random sampling techniques were used in selecting three schools for the study. The sample for the study is made up 151 SS II students in Nasarawa State South Senatorial District schools. This sample size is considered adequate as it possessed important characteristics which were representative of the target population. The sampled students were made up of 88 males and 63 females.

The instrument used for data collection was Equation of Motion Achievement Test (EMAT). Kuder – Richardson 21 (KR – 21) was used to determine the internal consistency of EMAT and  $r = 0.78$  was obtained as the coefficient of reliability. Descriptive statistics of means and standard deviation was used to answer the research

questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. Bonferroni Multiple Comparisons was used to

determine the direction of the difference between the groups.

## Data Analysis and Results

### Research One

What are the mean achievement scores of students taught equations of motion using concept maps, vee diagrams and the lecture method?

**Table 1: Mean Achievement Scores and Standard Deviations of Students Taught Equations of Motion Using Concept Maps and Vee Diagrams and Using Lecture Method**

Method		Pretest	Posttest
CM	Mean	23.31	32.02
	N	49	49
	Std. Deviation	4.997	3.886
VD	Mean	22.11	29.65
	N	46	46
	Std. Deviation	4.453	4.954
LM	Mean	17.86	26.39
	N	56	56
	Std. Deviation	3.787	3.217

**CM = Concept Maps, VD =Vee Diagrams, LM = Lecture Method**

Table 1 reveals the mean achievement scores of students taught equations of motion using

Concept Maps and Vee Diagrams and those taught using Lecture Method. The Concept Maps

group had a pre-test score of 23.31 and a post-test score of 32.02, the Vee Diagrams group

had a pre-test score of 22.11 and a post-test score of 29.65 and the Lecture Method group had

a pre-test score of 17.86 and a post-test of 26.39.

### Hypothesis One

**H<sub>01</sub>:** There is no significant difference in the mean achievement scores of students taught equations of motion using concept maps, vee diagrams and lecture method.

The result of analysis to test this hypothesis is presented in Table 4.2.

**Table 2: ANCOVA Result of Mean Achievement Scores of Students Taught Equations of Motion Using Concept Maps and Vee Diagrams and Using Conventional Method**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1713.466 <sup>a</sup>	3	571.155	55.028	.000	.529
Intercept	1953.683	1	1953.683	188.229	.000	.561
Pretest	873.019	1	873.019	84.112	.000	.364
Method	149.369	2	74.685	7.196	.001	.089
Error	1525.753	147	10.379			
Total	132093.000	151				
Corrected Total	3239.219	150				

a. R Squared = .529 (Adjusted R Squared = .519)

Table 2 reveals that  $F_{(2, 147)} = 7.196$  was obtained with associate exact probability value of 0.001 ( $F = 7.196$ ;  $P = 0.001 < \alpha = 0.05$ ). Since the associated probability (0.001) is less than 0.05 set as level of significance, the null hypothesis was rejected. This indicates that there was significant difference in the mean achievement scores of students taught equations of motions with Concept Maps

and Vee Diagrams and their counterparts taught with conventional method in favour of the Concept Maps.

Based on the established difference in the achievement scores of the groups, Bonferroni

Multiple Comparisons was used to determine the direction of the difference. The results of this analysis is shown in Table 3.

**Table 3: Bonferroni Multiple Comparisons Results of Mean Achievement Scores of Students Taught Equations of Motion Using Concept Maps and Vee Diagrams and Using Lecture Method**

(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	Sig. <sup>b</sup>	95% Confidence Interval for Difference <sup>b</sup>	
					Lower Bound	Upper Bound
CM	VD	1.709 <sup>*</sup>	.665	.034	.098	3.320
	LM	2.627 <sup>*</sup>	.710	.001	.908	4.347
VD	CM	-1.709 <sup>*</sup>	.665	.034	-3.320	-.098
	LM	.918	.690	.556	-.753	2.589
LM	CM	-2.627 <sup>*</sup>	.710	.001	-4.347	-.908
	VD	-.918	.690	.556	-2.589	.753

Based on estimated marginal means

\*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.



Table 3 shows that there was a significant difference in the mean achievement scores of students exposed to Concept Maps and Vee Diagrams and the Lecture Method. Concept Maps and Vee Diagrams had a P value of 0.034, since 0.034 is less than 0.05 set as level of significance, the hypothesis was rejected which implies a significant difference between the mean scores of students exposed to Concept Maps and Vee Diagrams in favour of the Concept Maps. Concept Maps and Lecture Method had a P value of 0.001, since 0.001 is less than 0.05

set as bench mark of significance, the hypothesis was rejected which implies a significant difference between the mean scores of students exposed to Concept Maps and Lecture Method in favour of the Concept Maps. Vee Diagrams and Lecture Method had a P value of 0.556, since 0.556 is greater than 0.05 set as bench mark of significance, the hypothesis was not rejected which implies no significant difference between the mean scores of students exposed to Vee Diagrams and Lecture Method.

### Research Question Two

What are the mean retention scores of students taught equations of motion using concept maps, vee – diagrams and the lecture method?

**Table 4: Mean Scores and Standard Deviation of Students Taught Equations of Motion Using Concept Maps and Vee Diagrams and Using Lecture Method**

Method		Posttest	Retention
CM	Mean	32.02	27.41
	N	49	49
	Std. Deviation	3.886	4.605
VD	Mean	29.65	28.11
	N	46	46
	Std. Deviation	4.954	4.067
LM	Mean	26.39	21.82
	N	56	56
	Std. Deviation	3.217	3.713

Table 4 reveals the mean retention scores of students taught equations of motion using Concept Maps and Vee Diagrams and Lecture Method. For the Concept Maps group, the post-test score is 32.02 and the retention score (Post-post-test) is 27.41. For

the Vee Diagrams group, the post-test score is 29.65 and the retention score (Post-post-test) is 28.11. For the Lecture Method group, the post-test score is 26.39 and the retention score (Post-post-test) is 21.82.

### Hypothesis Two

**H<sub>02</sub>:** There is no significant difference in the mean retention scores of Students taught

equations of motion using concept maps, vee diagrams and lecture method.

The result of analysis to test this hypothesis is presented in Table 4.9.

**Table 5: ANCOVA Result of Mean Retention Scores of Students Taught Equations of Motion Using Concept Maps and Vee Diagrams and Lecture Method**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2451.188 <sup>a</sup>	3	817.063	91.116	.000	.650
Intercept	68.238	1	68.238	7.610	.007	.049
Posttest	1202.318	1	1202.318	134.078	.000	.477
Method	373.228	2	186.614	20.811	.000	.221
Error	1318.190	147	8.967			
Total	102340.000	151				
Corrected Total	3769.377	150				

a. R Squared = .650 (Adjusted R Squared = .643)

Table 5 reveals that  $F_{(2, 147)} = 20.811$  was obtained with an exact associate probability value of 0.000 ( $F = 20.811$ ;  $P = 0.000 < \alpha = 0.05$ ). Since the associate probability (0.000) is less than 0.05 set as level of significance, the null hypothesis was rejected. This implies that there was significant difference was found to exist in the mean retention scores of students taught equations of

motion using Concept Maps and Vee Diagrams and Lecture Method.

Based on the established difference in the achievement scores of the groups, Bonferroni Multiple Comparisons was used to determine the direction of the difference. The results of this analysis is shown in Table 6.

**Table 6: Bonferroni Multiple Comparisons Results of Mean Retention Scores of Students Taught Equations of Motion Using Concept Maps and Vee Diagrams and Using Lecture Method**

(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	Sig. <sup>b</sup>	95% Confidence Interval for Difference <sup>b</sup>	
					Lower Bound	Upper Bound
CM	VD	-2.377*	.632	.001	-3.907	-.848
	LM	1.603	.679	.059	-.043	3.248
VD	CM	2.377*	.632	.001	.848	3.907
	LM	3.980*	.628	.000	2.458	5.501
LM	CM	-1.603	.679	.059	-3.248	.043
	VD	-3.980*	.628	.000	-5.501	-2.458

Based on estimated marginal means

\*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 6 shows that there was a significant difference in the mean retention scores of

students exposed to Concept Maps and Vee Diagrams and the Lecture Method. Concept

Maps and Vee Diagrams had a P value of 0.001, since 0.001 is less than 0.05 set as bench mark of significance, the hypothesis was rejected which implies a significant difference between the mean scores of students exposed to Concept Maps and Vee Diagrams. Concept Maps and Lecture Method had a P value of 0.059, since 0.059 is greater than 0.05 set as bench mark of significance, the hypothesis was not rejected which implies no significant difference

### **Discussion of Findings**

The findings of this study revealed that there was a significant difference in the mean achievement scores of students taught equations of motions with Concept Maps and Vee Diagrams and their counterparts taught with conventional method in favour of the Concept Maps. This finding is in agreement with the findings of Theophilus (2020), Mehmet and Erkol (2019), Onyejokwe, Uchendu and Nmon (2018), Okefienna (2018), Mehmet (2017), Otor (2016), Obi and Okeke (2016), Uche and Alberto (2016), Osisioma (2016), Wandersee (2016) who in their various

researchers found out that Concept Maps and Vee Diagrams enhances students achievement in science subjects.

between the mean scores of students exposed to Concept Maps and Lecture Method.

Vee Diagrams and Lecture Method had a P value of 0.000, since 0.000 is less than 0.05 set as bench mark of significance, the hypothesis was rejected which implies a significant difference between the mean scores of students exposed to Vee Diagrams and Lecture Method

The trend of improved achievement by the treatment groups could be as a result of the enabling learning environment provided where students were motivated and encouraging one another to learn. Another reason for better achievement could be because the students were captivated, more focused, attentive and interested in what they were doing. This no doubt offered slow learners the opportunity to catch up with the fast learners.

The findings revealed that there was no significant difference found to exist in the mean retention scores of students taught equations of motion using Concept Maps and Vee Diagrams and Lecture Method. This finding is in agreement with the findings of Theophilus (2020), Mehmet and Erkol (2019), Onyejokwe, Uchendu and

Nmon (2018), Okefienna (2018), Mehmet (2017), Otor (2016), Obi and Okeke (2016), Uche and Alberto (2016), Osisoma (2016), Wandersee (2016) who in their various researches found out that Concept Maps and Vee Diagrams enhances students retention in science subjects.

This affirms that active learning as provided by Concept Mapping and Vee Diagrams instructional strategies facilitated active knowledge construction developed higher order thinking skills, improved memory and enhanced transfer of learning to other situations. This enhanced the retention of learning which was not affected. Thus, Concept Maps and Vee Diagrams instructional strategies are significantly very useful for increased meaningful learning and higher retention of students regardless of their ability.

## Conclusion

The findings of this study have shown that Concept Maps is more effective than the

Vee Diagrams and Lecture Method. Evidently, both Vee Diagrams and Concept Maps help students develop a rich system of concepts and their learning, strategies. Both stimulate students not only to use concepts the students have already internalized but also to build conceptual interconnections. The conceptual interconnections help students formulate theoretical explanations about observed changes.

## Recommendations

Based on the findings of this study, it was recommended that,

1. Since Concept Maps and Vee Diagrams are found to be an effective strategy for improving students' achievement, teachers should be endeavour to use Concept Maps and Vee Diagrams in the teaching of Equations of motion.
2. Students should be taught how to construct concept maps on their own on various topics in Physics because this improves the cognitive structures of the students.

## REFERENCES

- Adeyemo, S. A., & Babajide, V. F. T. (2014). Effects of mastery learning approach on students' achievement in physics. *International Journal of Scientific & Engineering Research*, 5(2), 910-920. Retrieved March 1, 2017, from <http://www.ijser.org/researchpaper/effects-of-mastery-learning-approach-on-students.pdf>
- Bashayi & Samuel** *JSTE Publications*, 2022.

- Eria, S. T. (2015). How to use different formats of concept maps in teaching. *Journal of Research in Science Teaching*, 43(10), 650 – 665.
- Eric, B. I. (2015). The Effect of Concept Mapping and Cognitive Style in Science Achievement. *Dissertation Abstract International*, 49(6), 1420.
- Erinosho. S. Y., & Onabanjo, O. (2013). How do students perceive the difficulty of physics in secondary schools? An exploratory study in Nigeria. *International Journal for Cross-Disciplinary Subjects in Education*, 3(3), 1511-1515. Retrieved December 29, 2016, from <http://infonomics-society.org/wp-c>.
- Federal Republic of Nigeria (FRN) (2014). *National Policy on Education* (6<sup>th</sup> ed.). Lagos: NERDC Press.
- Gambari, A. I., Emmanuel, K., & Ikusanu, T. (2014). Efficacy of computer-based simulation on students' achievement in physics education. *Indo-African Journal of Educational Research*, 2(1), 15-20. Retrieved December 2, 2016, from <http://iajer.rstpublishers.com>
- Gambari, A. I., Yusuf, M. O., & Thomas, D. A. (2015). Effects of computer-assisted STAD, LTM and ICT cooperative learning strategies on Nigerian secondary school students' achievement, gender and motivation in physics. *The Malaysian Online Journal of Educational Science*, 3(4). Retrieved April 19, 2017, from [http://www.mojes.net/frontend/articles/pdf/v03\\_i04/v03-i04-02.pdf](http://www.mojes.net/frontend/articles/pdf/v03_i04/v03-i04-02.pdf).
- Guewwe, X. L. (2014). An investigation of the effectiveness of concept mapping as a meta – cognitive tool in physics. *Science Education*, 81(1).
- Guewwe, A. J. Hill, S. Carvaho M, Petrside, M. & Smith, D. (2014). Concept maps integrating knowledge and information visualization. In S.O. Tergan & T. Keller (Eds.), *Knowledge and Information Visualization: Searching for Synergies* (pp. 205 – 219). Heidelberg/NY: Springer Lecture Notes in Computer Science.
- Guewwe, D. A. S., Horton, P. B., Moennoy, A. A., & Hemelin, A. (2014). Effect of concept mapping as a teaching technique and Ecological Context. Editorial Oxford: Pagumen Press.
- Heil, I. A. (2015). Evaluation of mapping as a tool for meaningful education of college biology students. *Dissertation Abstract International* 48(1), 95.
- Issam, B. A., & Fouad, M. T. (2015). Effect of concept mapping on student's achievement in Algebra. *Journal of Science, Mathematics and Technology Education Vol. 1/1* El Faruk Publishers, Katsina.
- Krishnaratue D., A., Coffey, J. W., Hoffman, R.R., Canas, A.J. & Ford, K.M, (2014). A concept map-based knowledge modeling approach to expert knowledge sharing. In M. Bournedine (Ed.), *Proceedings of IKS 2012 – The LASTED International Conference on Information and Knowledge Sharing* (pp. 212 – 217). Calgary, Canda: Acta Press.
- Mehmet, E. (2017). Effect of vee diagram on the achievements and attitudes of students in science laboratory course II. *New Trends and Issues proceedings on Humanities and Social Science 8<sup>th</sup> World Conference on Education Sciences*. Vol. 3 No. 1
- Mehmet, K. & Erkol, A. (2019). Effects of vee diagram on the achievement and attitudes of students in science laboratory course I.
- Munyanadzi, W. A. (2014). *Measurement and Evaluation in Education and*

- Psychology, 2<sup>nd</sup> Edition*. New York: Holt, Reinhart and Winston.
- Nikita, C. O., Browuse, X. L., & Surzette, M. (2015). The use of concept mapping and knowledge vee – mapping with Junior high school science students. *Science Education*, 67(5), 625 – 645
- Novak, J. D. (1983). Learning, creating and using knowledge. New York: Routledge.
- Novak, J. D., & Gowin, D. B. (2005). Concept maps and Vee diagrams: Two metacognitive tools to facilitate meaningful learning. *Instructional Science*, 19 (1), 29-52.
- Obafemi. D. T. A., & Onwioduokit, F. A. (2013). Identification of difficult concepts in senior secondary school two (SSII) physics curriculum in River State, Nigeria. *Asian Journal of Education and e-Learning*, 1(5), 317-322.
- Obi, E. & Okeke, N. (2016). Effects of concept mapping on student's achievement in Algebra. Implications for secondary school mathematics education in the 21<sup>st</sup> century. *Journal of Science and Arts Teachers Vol 1/6*. Okigwe Publishers Onitsha.
- Okefiena, D. N. (2018). The effects of concept mapping on students' achievement and interest in some selected units in biology. Unpublished M.Ed. Thesis University of Nigeria, Nsukka.
- Okeke, A. O. (2014). Concept mapping with a cooperative learning flavour. *The Amercia Biology Teacher*, 54(4), 218 – 221.
- Okoro, A. I. (2014). The effect of concept mapping in teaching Chemistry. Unpublished M.Ed. Thesis, University of Nigeria, Nsukka.
- Onyejekwe, C. A, Uchendu, G. & Nmon, T. (2018). Effect of concept mapping on students' performance in genetics, in selected public schools in Obio/Akpor. *International Journal of Education and Evaluation Vol. 1 No. 1*.
- Osborne, W. S. (2016). Concept Mapping in Sciences: A case study of 3<sup>rd</sup> grade students. *Educational Technology and Society*, 1 (1), 186 – 195.
- Osisoma, U. I. N. (2015). Effects of modes of concept mapping and gender on students' achievement in and attitude towards Integrated Science. Unpublished Ph.D. Thesis, University of Nigeria, Nsukka.
- Otor, E. (2016). Effect of concept mapping strategy on students' achievement in difficult chemistry concepts in rural and urban areas in Benue State, Nigeria. *International Journal of case studies Vol. 2, Issue 8*.
- Oyelade, O. T. (2016). *Today's physics for senior secondary schools and colleges*. Ibadan: Osated Publications.
- Ra'ed, A. & Khedr, A. H. (2013). The effect of using concept mapping in teaching physics on academic achievement of the first-year students in Oman. *Scottish Journal of Arts, Social Services and Scientific Studies*.
- Richard, E. M. (2015). The effects of graphical concept maps as facilitative tools in teaching physics. *Innovations on Education and Teaching International* 42(1), 132 – 140.
- Ross, M. A. N. & Mumby, R. C. (2013). Effect of concept mapping and misconception in student's achievement and retention in chemistry. *Journal of Science Teacher and Engineers Vol. (1) XILX Publisher, USA*.
- Smith, K. O. (2015). Concept mapping: A useful tool for science education.

- Journal of Research in Science Teaching*, 47(10), 937 – 947
- Soares, M. E. & Valadares, J. (2016). Using concept maps as a strategy to teach physics, in a particular topic of acoustics. Retrieved on 12/02/2018 from <http://cmc.hmc.us/cmc2016.pdf> p. 36
- STAN (2014). *Science Teachers Handbook*. Ibadan: Longman
- Star, M. L & Krajcik, J. S (2016). Concept map as a heuristic for science. Curriculum towards improvement in process and product. *Journal of Research in Science teaching*, 47(10) 967 – 1000
- Stensvold, W.S (2014). Effect of concept mapping in conjunction with chemistry laboratory. *Journal of Science Educators and Administrators Vol.1* (2) IOWA Publishers.
- Stoddort, H, Robert, T.E, Abraham, S., & Erika, H. (2015). Effect of Concept maps and vee diagrams under three learning modes on students' cognitive achievement in ecology and genetics. *Journal of Science and Related Science Educators Vol. 1/1*. Olu Printers, Lagos.
- Theophilus, N. J. (2020). The effect of concept mapping on students' achievement in Biology in Senior Secondary Schools in Aba Educational Zone of Abia State. Thesis.
- Uche, N. & Alberto, O. (2016). Effects of concept maps on student's achievement, interest and retention in organic chemistry. *Journal of Millennium Teachers*, Vol. 1/1 Okondo Publishers Nsukka.
- Udeani, S. K. L (2015). Effect of concept mapping on Biology achievement of senior Secondary School Low Learners. *Journal of Professional Science Teachers Vol. 1/1*. Express Publisher Jos.
- Udo, N. N., & Ubana, A. U. (2013). Teaching Physics for Retention. *International Journal of Modern Management Sciences*, 2(1), 18-25. Retrieved November 11, 2016, from <http://www.ModernScientificPress.com/Journals/IJMGMTS.aspx>.
- Ukpai, P. O., Gabriel, O. Okechukwu S. Abonyi J.O., & Ugama, K. (2016). Effects of Concept Mapping Instruction Approach on Students' Achievement in Basic Science Department of Science Education, Ebonyi State University, Abakaliki. *Journal of Education and Practice* www.iiste.org ISSN 2222-1735 (Paper) ISSN 2222-288X (Online) Vol.7, No.8, 2016 79.
- Uzor, N. (2019). Effects of concept mapping on students' achievement in Biology: *International Journal of Educational Enterprises Vol. 10. Issue 3*. Aba Education Publishers, Abia State, Nigeria.
- Victor, D. H. (2014). Concept mapping and the cartography of cognition. *Journal of Research in Science Teaching*, 27(10), 923 – 936
- Wallace, R. S. & Auntz, T. M. (2015). Assessing meta-cognitive strategy of concept mapping as a tool for reducing anxiety and enhancing achievement in Biology in Nigeria. *Journal of Arts and Science Teachers Vol. 1/1*.
- Wanbugu, P. W., Changeiywo, J. M., & Ndiritu, F. G. (2013). Investigations of experimental cooperative concept mapping instructional approach on secondary school girls' achievement in physics in Nyeri County, Kenya. *Journal of Education and Practice*, 4(6), 120-130.
- Wandersee, U. N. (2016). Effect of concept mapping on students' achievement in

- Algebra: Implication for secondary mathematics education in the 21<sup>st</sup> Century. *Journal of Mathematics Education, 1(1)*, 1 – 13.
- Yusuf, M. O., Gambari, A. I., & Olumorin, C. O., (2012). Effectiveness of computer-supported cooperative learning strategies in learning physics. *International Journal of Social Sciences & Education, 2(2)*, 94-109.
- Zachariah, K. M., Gbatala, J. & Frayer, A. D. (2014). The effect of concept mapping on students' anxiety and achievement in biology. In Jegede, et al (eds.), *Journal of Researcher in Science Teaching, 47(10)*, 951 – 960.