

Effect of Teaching through Concept-Mapping and Vee-Mapping on Achievement in Biology in Relation to Gender Difference of Senior Secondary School Students of Taraba State

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ABSTRACT

This study investigated the effect of teaching through concept-mapping and vee-mapping on academic achievement in biology in relation to gender difference of senior secondary school students of Taraba state. Two research questions were raised and two null hypotheses were formulated to guide the study. The study was a nonequivalent pretest posttest quasi experimental design involving two experimental groups and a control group. Three schools were purposively selected and 152 SSII students formed the sampled population. Three intact classes from three schools were assigned to the experimental and control groups. Biology achievement test (BAT) was the research instrument used for data collection. The reliability of the instrument was computed using Kuder Richardson (K-R 21) and was found to be 0.80. Mean and standard deviation, ANCOVA were used to analyze and interpret data collected. The result of the study showed that, there is statistical significant difference in academic achievement of senior secondary school students taught Biology with Concept-mapping and Vee-mapping teaching strategies and lecture methods in favour of Concept-mapping and Vee-mapping ($F= 0.80$ (df 2,148), $p=0.00$). There is no significant gender difference in academic achievement of senior secondary school students taught Biology with Concept-mapping, Vee-mapping teaching strategies and lecture method of teaching ($F=0.58$ (df 1,152), $p=0.446$). Based on the findings, it was recommended that teachers, curriculum designers, institutions and other stake holders in education should adapt the use of Concept-map and Vee-map instructional approach in teaching Biology in our schools. Teachers should be involved in workshops so as to train them on how to use these strategies.

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INTRODUCTION

Education is a process through which a person is encouraged and enabled to develop his/her capacity. It is a process that is very important for the success of an individual in the society. This is because it provides learners with the knowledge and skills that prepares them for the works of life. It is through these that the society grows and develops by bringing about the

desired societal changes (Kenneth, 2013). It serves the purpose of preparing the individual with what is necessary to be productive and contribute positively to ones' society (Nnoli, 2016). Education revolves around the teacher, student and curriculum, where the teacher plays very important role in imparting the right value in the future generations. For the process of teaching and learning to succeed the teacher has

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to deliberately organize the learning experiences in such a way that the objectives or the learning needs of the learners are met at the end of the learning process (Njoku, 2016). The content and techniques of teaching depend to a large extent on what one wants to achieve. In a changing world, education is supposed to find ways and means to improve the teaching techniques to cope with the need of the times (Rajwinder, 2018). An individual acquires knowledge and skills through creative teaching and learning. Effective teaching therefore, is crucial to learning because the product of teaching such as knowledge, skills and attitude acquisition are much dependent upon the teacher's effective approach to impacting knowledge.

In the past decades, there is increasing awareness of the importance of learner centeredness in the teaching-learning Process. This has drawn a lot of attention in relation to understanding how learners learn and how to help them learn about new concepts. Global change in science education curriculum which came as a result of explosion in knowledge and the corresponding progress in technology, demands qualitative and functional approaches to teaching and learning processes (Gbadamosi, 2013). Science is a dynamic human activity concerned with understanding of how our world works. This understanding helps man to know more about the universe. Without the applications of the basic disciplines of science such as Biology, Chemistry, Mathematics, Physics, it would have been difficult for man to explore other planets of the universe (Maruff, Amos, Gbolagade & Olawale, 2011). The yardstick that characterizes the world into developed and developing countries are the level and quality of science education which is achieved through effective science teaching of the young generation.

Considering its fundamental characteristics and importance to humanity, Biology is a core subject taught at all levels of our educational systems, from pre-primary to tertiary levels. Citing Kara and Rogers (2012), Obioha and Danjuma (2021) maintain that Biology encompasses diverse fields, including botany,

conservation, ecology, evolution, genetics, marine biology, medicine, microbiology, molecular biology, physiology, and zoology. Although the subject is a prerequisite to these courses, in Nigeria poor achievement in the subject is alarming. Educators in the field of Biology have advocated for the use of the constructivist (student centered) methods that would make learning more meaningful through students' active participation (Mwanda, Odundo, & Midigo 2017, Dogra 2021). It is assumed that this will improve achievement and attitude towards the learning of the subject.

Several reasons have been profered as causes of poor achievement of students in Biology by different researchers. One of such factors aside others is the methods used in teaching the subject (Manalanga & Awelani, 2014). According to Joda (2018), exposing learners to the understanding of basic concepts in Biology and achieving desirable outcomes require the use of creative, innovative and interactive teaching approaches. This implies that to improve student's achievement in Biology they must be involved meaningfully in the teaching and learning process. In airing their view, Sakiyo and Waziri, (2015) maintain that there is need for the students to be given a more realistic teaching approach that will cushion and fasten their ability to learn new concepts with students' learning manners. Biology teachers therefore need to exploit a host of teaching and learning approaches and move away from the traditional method of teaching which is focused mainly on what the teacher can give and the students as perceive participants. The teacher-centered approach seems to encourage only memorization of concepts by the students without developing the cognitive capability to apply them in solving problems

In any society that wish to advance scientifically and technologically, the concern of every science educator is the academic achievement of students irrespective of gender disposition. Gender as a factor in the learning of science particularly in Biology is very important because gender disparity has not only been an issue in daily life matters but also in academic

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achievements of students. In the African society the assignment of roles and expectations by the traditional society to males and females results into perception of science as a masculine subject rather than feminine. Consequently, female upbringing appears to shape them away from science and technology (Nzewi, 2010). However, findings have not been consistent from various experts in science education on the effect of gender differences on academic achievement. Anita and Nzewi (2015) pointed out that, in Nigeria gender bias is still prevalent in our educational system and has persisted even within the science classroom.

Concept-mapping is a means of developing logical thinking and study skills by revealing connections and helping students to see how individual ideas form a larger whole. The instructional strategy had its origin in the learning movement called constructivism. It basically hinged on Ausubel's meaningful learning theory (1963) which is also known as the subsumption theory. The theory states that "learning takes place by the assimilation of new concepts and propositions, into existing concepts and propositional frameworks". Ausubel's (1968) assimilation theory of cognitive learning focussed on the central role that prior concepts play in the acquisition and use of knowledge and the contrast between rote and meaningful learning. This theory recognizes knowledge structure held by an individual learner as the learner's cognitive structure. In Ausubel's view, to learn meaningfully, a Learner must relate new knowledge (concepts and propositions) to what already exist in his cognitive structure (Ausubel, Novak, & Hanesian, 1978). Novak and Gowin (1984) introduced two constructivist heuristic tools that will describe explicit changes in children's conceptual understanding. These two metacognitive tools are Concept-map and vee-map which could serve as cognitive map for helping students to understand the meaning of knowledge. According to Gowin and Novak. These metacognitive tools serve as visual cognitive road map showing some pathways the students may take to connect meanings of concepts. They pointed out that human

constructivism maintain that knowledge whatever it may be, is constructed based on a complex interaction between two major components, one conceptual and another methodological, and that this interaction involves several epistemological blocks.

Studies carried out on the effects of Concept-mapping teaching strategy have shown male students perform better than female students in science (Novak & Mosunda, 2010) and (Kyei, Apam & Nokoe, 2011, Dania 2014). Agbaje and Alake (2014) found in their study no significant gender difference in students' academic achievement in science subjects. Agbaje and Alake (2014) found in their study no significant gender difference in students' academic achievement in science subjects. Nwona and Akogun (2015) in their study had a similar outcome in favour of female students performing better than their male counterparts in science technology and mathematics. Joy (2015) investigated the effect of concept-mapping method of instruction and expository method on students' academic achievement in chemistry. The study found that, students taught using concept-mapping teaching approach achieved higher than those taught using expository method (Lecture method). The female students achieved higher than the male students in the post-test scores. Sakiyo and Waziri (2015), Joda (2018) studied the effect of concept mapping instructional strategy on senior secondary school students' academic achievement in Biology in Adamawa state. The results indicates no statistically significant difference in achievement mean score of students taught Biology using concept mapping and expository teaching method. The result also revealed that there was no significant effect of treatment on the mean achievement scores of male and female students taught Biology using concept mapping. In another study, Kaponde (2019) investigated the effect of concept mapping in group discussion as an instructional strategy on the academic achievement of learners in genetics and also if achievement varies with gender. The result indicates a significant main effect of the teaching approach on the students'

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academic achievement, but found gender to have no effect on the students' achievement. Similarly, Bilesanmi (2021) in a study on the effect of Cocept-mapping teaching approach on the achievement of biology students discover that the concept-mapping teaching strategy is more effective in enhancing students' achievement in biology than the lecture method. However, the finding, also found no significant main effect of gender on the academic achievement of the students.

Teaching and learning science requires understanding of concepts through assimilation of new ones into existing concepts. Vee-mapping as a novel teaching approach has been studied by educators with the view of ascertaining its effect on students' academic achievement and to what extent it is influenced by students' gender. Njue and Magana(2016) studied the effects this teaching approach on students' achievement in Biology based on gender ..The researchers found that Vee-mapping teaching Approach (Vee-Heuristics) facilitated Students' achievements in biology regardless of gender.In a similar study, Musa, Bernadette and Veronica (2018) investigated the effects of Vee-mapping teaching strategy on male and female students in basic science from junior secondary schools. The result of the study shows no significant differences between the performance of male and female students. Yerima, Muazu and Hamidu (2017) in a study on senior secondary school chemistry students found male students outperforming female students when vee-mapping was used as a teaching strategy..

It could be acknowledged that the studies carried out on these two teaching approaches shows inconsistent findings as to their effect on students' academic achievement and gender. It is against this backdrop that concept-mapping and vee-mapping teaching strategies were studied in this work in order to explore more on their comparative advantage over the conventional traditional lecture method of teaching science specifically in Taraba state.

Statement of Problem

Over the years studies carried out by experts in science education indicates persistent

students' low level of achievement in biology at the various public examinations in Nigeria. This has continued to attract the attention of major stakeholders in education. Available statistics from the West African Examination Council (WAEC) from 2010-2020 indicates that, students' achievement in biology at the senior secondary school level has not been consistent but continues to fluctuate over the years.

Information from the Taraba state ministry of basic and secondary education resource centre Jalingo on statistics of students' WAEC achievement in biology for the past eight years 2011-2019 shows achievement has not been consistent but fluctuates and in some years the failure rate is very alarming- 2013 (32.5%), 2015 (83.16%) and 2019 (21.75%). More worrisome is the fact that this unimpressive trend means students might have been having hard time transiting to tertiary institutions and gaining meaningful employment opportunities in the state and the country at large. This continued pattern in achievement in this public examination might be an indicator of teachers not exploring better teaching strategies.

Teaching some biological concepts can be difficult because of their abstract nature, and complexity of some topics .This situation calls for alternative methods of teaching that could lead to meaningful and effective learning outcome. Concept-mapping and Vee-maping teaching strategies have been identified as recent approaches in teaching that could be useful tools for processing, organizing and presenting information graphically .Consequently, it is in view of this that this study was designed to explore the comparative advantage of Concept-mapping and Vee-mapping teaching strategies over that of the traditional lecture method in teaching Biology topics. The study determined their effects teaching with Concept-map and Vee-map teaching strategies on Biology students' academic achievement and gender in Taraba state senior secondary schools.

Purpose of the study

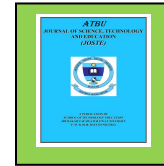
The study has the following specific objectives; to determine the

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1. Effect of Concept-Mapping and Vee-Mapping teaching strategies and Lecture method on academic achievement of senior secondary school Biology students in Taraba state.
2. Effect of gender on academic achievement of senior secondary school Biology students taught with Concept-Mapping and Vee-Mapping teaching strategies and those taught with Lecture method in Taraba state

Research Questions

The study answered the following research questions;

1. What are the pre-test and post-test mean achievement scores of senior secondary school students taught biology with Concept-mapping and Vee-mapping teaching strategies and those taught with lecture method in Taraba state?
2. What are the mean achievement scores of male and female senior secondary school students taught biology with Concept-mapping and Vee-mapping teaching strategies and those taught with Lecture method in Taraba state?

Hypothesis

The following null hypothesis were raised and tested at 0.05 level of significance;

HO₁ There is no statistical significant main effect of Concept-mapping, Vee-mapping teaching strategies and lecture method on senior secondary school students' academic achievement in Biology in Taraba state.

HO₂ There is no statistical significant main effect of gender on academic achievement of senior secondary school students when taught Biology with Concept-mapping, Vee-mapping teaching strategies and lecture method in Taraba state.

METHODOLOGY

The research design for this study was a pre-test post-test nonequivalent quasi-experimental control group design. This design permits purposive sampling of students into groups since the students were in their intact classes to avoid interruption of normal class activities. The study consisted of three groups- groups I and II as experimental groups and group III as control group. The instrument used for collecting data about students' academic achievement was a Biology Achievement Test (BAT) which was a 50 item multiple choices (MCQ) test. Each item on the test has five options lettered A-E, one of which must be correct. The topics selected for the test were; Components of the ecosystem, Energy flow in the ecosystem and Interactions in the ecosystem. The test items were set in accordance with the six behavioral objectives in the cognitive domain of Bloom's taxonomy of educational objectives- knowledge, comprehension, application, analysis, synthesis and evaluation. The BAT was given to four experts; two with science education background from the department of Environmental and Life Sciences Education Modibbo Adama University Yola, one from Government Day Secondary School A.T.C Kofai Jalingo with at least five years teaching experience, and one with Biology education background from College of Education Zing, for face and content validation. They were requested to assess the clarity of terms, relevance of items, content coverage, and correctness of provided answers and to make suggestions and corrections where necessary. This was to ensure proper coverage of selected topics, well stated questions, and relevant distractors A-E.

RESULTS

Research Question 1 What are the pre-test and post-test mean achievement scores of senior secondary school students taught biology with concept-mapping, vee-mapping teaching strategies and those taught with lecture method in Taraba state?

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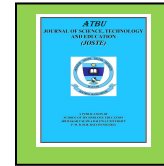


Table 1: Mean And Standard Deviation of Pre-Test and Post-Test Mean Achievement Scores of Senior Secondary School Students Taught Biology with Concept-Mapping, Vee-Mapping Teaching Strategies and those Taught with Lecture Method in Taraba State.

Teaching Strategies	n	Mean	Pretest		Posttest	
			SD	Mean	SD	Mean
Concept-mapping	49	42.29	12.69	45.18	13.83	
Vee-mapping	50	34.80	11.69	41.48	13.79	
Lecture Method	53	38.11	14.66	34.98	12.09	

The descriptive statistics in Table 1 revealed that, concept-mapping group with 49 students has a pretest mean achievement score of 42.29 and standard deviation of 12.69. In the posttest achievement score, concept-mapping group has the highest mean achievement score of 45.18 with a standard deviation of 13.83. The Vee-mapping group with 50 students has a pretest mean achievement score of 34.80 and standard deviation of 11.69. In the posttest achievement score, Vee-mapping group has the mean achievement score of 41.48 with a standard deviation of 13.79. The conventional Lecture group with 53 students has a pretest mean achievement score of 38.11 and standard deviation of 14.66. In the posttest achievement scores, conventional Lecture group has the mean achievement score of 34.98 with a standard

deviation of 12.09. In summary, the mean difference between pretest and posttest is high which means the teaching strategies and Lecture method under study (concept-mapping, Vee-mapping teaching strategies and Lecture method) were equally important at improving students' achievement at different levels. Concept-mapping strategy shows slightly better mean achievement scores than Vee-mapping strategy and Lecture method of teaching

Research Question 2 What are the mean achievement scores of male and female senior secondary school students taught biology with concept-mapping and vee-mapping teaching strategies and those taught with Lecture method in Taraba state?

Table 2: Mean and Standard Deviation of Pre-Test And Post-Test Mean Achievement Scores of Male And Female Senior Secondary School Students Taught Biology with Concept-Mapping and Vee-Mapping Teaching Strategies and those Taught with Lecture Method In Taraba State.

Teaching Strategies	N	Gender	Mean	Std. Deviation
Concept-Mapping	28	Male	42.57	11.97
	21	Female	48.66	15.59
Vee-Mapping	27	Male	42.81	15.63
	23	Female	39.91	11.41
Lecture Method	26	Male	33.07	11.49
	27	Female	36.81	12.56

The descriptive statistics in Table 2 revealed that, concept-mapping group with 49 students (28 males and 21 females), the male group has a posttest mean achievement score of 42.57 and standard deviation of 11.97. While, the female posttest scores concept-mapping group has the mean achievement score of 48.66 with a

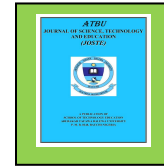
standard deviation of 15.59. The Vee-mapping group with 50 students (27 males and 23 females), the male group has a posttest mean achievement score of 42.81 and standard deviation of 15.63. While, the female posttest achievement score Vee-mapping group has the mean attitude score of 39.91 with a standard

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deviation of 11.41. The conventional Lecture method group with 53 students (26 male and 27 female), the male group has a post-test mean achievement score of 33.07 and standard deviation of 11.49. While, the female posttest mean achievement score is 36.81 with a standard deviation of 12.56. In summary, the mean difference between male and female is low which means gender has not much contribution on students' achievement.

Hypotheses Testing

Hypotheses 1-2 were tested using ANCOVA at 0.05 level of significance.

HO₁ There is no statistical significant main effect of Concept-mapping, Vee-mapping teaching strategies and lecture method on senior secondary school students' achievement in Biology in Taraba state.

Table 3: ANCOVA Table of Main Effect of Concept-Mapping, Vee-Mapping Teaching Strategies and Lecture Method on Senior Secondary School Students' Academic Achievement in Biology in Taraba State.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Squared	Eta
Corrected Model	3306.705 ^a	3	1102.235	5.682	.001	.103	
Intercept	20584.853	1	20584.853	106.121	.000	.418	
PRETEST	263.486	1	263.486	1.358	.246	.009	
TEACHING_METHODS	2523.172	2	1261.586	6.504	.002	.081	
Error	28708.235	148	193.975				
Total	278023.000	152					
Corrected Total	32014.941	151					

a. R Squared = .103 (Adjusted R Squared = .085)

The results of the analysis in Table 3 revealed that, there is significant difference in academic achievement of senior secondary school students taught biology with concept-mapping, vee-mapping teaching strategies and lecture method $F = 6.50$ ($df 2, 151$), $P = 0.00$. Since the computed p -value (0.001) is less than 0.05 level of significant, therefore, the null hypothesis of no significant difference is rejected and concluded that, there is significant difference

in academic achievement of senior secondary school students taught biology with concept-mapping, vee-mapping teaching strategies and lecture method in favour of concept-mapping and vee-mapping method. The partial eta square of 0.081 shows that 8.1% of students' academic achievement is attributed to the treatments, Concept-mapping and Vee-mapping teaching strategies.

Table 4. Bonferroni Multiple Comparison Analysis Table of Main Effect of Concept-Mapping, Vee-Mapping Teaching Strategies and Lecture Method on Senior Secondary School Students' Academic Achievement in Biology in Taraba State.

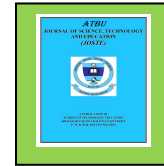
(I) Teach.Strats	(J) Teach,Strats	Mean Difference (I- J)	Std. Error	Sig	95% Confidence Interval Lower Bound	Upper Bound
Concept-Mapping	Vee-Mapping	3.70	2.66	0.02	-1.55	8.96
	Lecture Method	10.20	2.62	0.00	5.01	15.38
Vee-Mapping	Concept-Mapping	-3.70	2.66	0.16	-8.96	1.55
	Lecture Method	6.49	2.60	0.01	1.34	11.65

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Lecture Method	Concept-Mapping	-10.20	2.62	0.00	-15.38	-5.01
	Vee-Mapping	-6.49	2.60	0.01	-11.6	-1.34

Table 4 showed the results of Bonferroni Multiple Comparisons of treatments. The result revealed that there is a significant mean difference in academic achievement between concept-mapping and vee-mapping teaching strategies ($p = 0.02$) with a mean difference of 3.70 in favour of concept map. There is also a significant difference between concept-mapping strategy and lecture method ($p = 0.00$) with a mean difference of 10.20 in favour of concept-mapping strategy. There is a significant difference between vee-mapping strategy and lecture method ($p = 0.01$) with a

mean difference of 6.49 in favour of vee-mapping strategy. The result indicated that, concept-mapping group performed better than vee-mapping strategy and lecture method groups while, vee-map strategy group performed better than lecture group.

HO₂ There is no statistical significant main effect of gender on academic achievement of senior secondary school students when taught Biology with Concept-mapping, Vee-mapping teaching strategies and lecture method in Taraba state.

Table 5. ANCOVA Table of Main Effect of Gender on Academic Achievement of Senior Secondary School Students when Taught Biology with Concept-Mapping, Vee-Mapping Teaching Strategies and Lecture Method in Taraba State.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	784.559 ^a	2	392.279	1.872	.157	.025
Intercept	18541.876	1	18541.876	88.463	.000	.373
PRETEST	780.971	1	780.971	3.726	.055	.024
GENDER	1.026	1	1.026	.005	.944	.000
Error	31230.382	149	209.600			
Total	278023.000	152				
Corrected Total	32014.941	151				

a. R Squared = .025 (Adjusted R Squared = .011)

The results of the analysis in Table 5 revealed that, there no significant statistical main effect of gender on academic achievement of senior secondary school students taught biology with concept-map, vee-mapping teaching strategies and lecture method $F = 0.005$ (df 1, 151), $P = 0.944$. Since the computed p-value (0.944) is greater than 0.05 level of significant, therefore, the null hypothesis of no significant difference is upheld and concluded that, there is no significant gender difference in academic achievement of senior secondary school students taught biology with concept-mapping, vee-mapping teaching strategies and lecture method. The partial eta square of 0.000 indicates that 0%

of the academic achievement of students is attributed to the effect of gender.

FINDINGS OF THE STUDY

The study revealed the following findings:-

1. There is statistical significant main effect of the treatments (Concept-mapping, Vee-mapping teaching strategies and Lecture Method) on senior secondary school students academic achievement .Bonferroni analysis shows that students in the concept-mapping teaching strategy group achieved better followed by vee-mapping and lecture is the least .
2. There is no statistical significant main effect of gender on academic achievement of senior

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secondary school students taught biology with concept-mapping, vee-mapping teaching strategies and lecture method.

CONCLUSION

The descriptive statistics analysis and hypothesis testing indicates that all the groups had shown increment in academic achievement mean scores after being exposed to the treatments. This shows that both experimental groups had a significant knowledge increment about the topics taught with concept-mapping and vee-mapping teaching strategies. The positive effect of these teaching strategies indicates that the overall framework of the concepts being learned were made explicit by the teaching strategies which ensured better organisation of the material presented by both the students and the teachers during the lessons which promoted meaningful learning. The hypotheses testing indicates similar trend; concept-mapping teaching strategy has better impact on biology student' academic achievement compared to Vee-mapping teaching strategy with lecture method having the least impact. The results shows that these teaching approaches shows no significant effect on academic achievement based on gender. This outcome disagrees with the findings of Ahmad and Munawar (2013) who reported otherwise that when students were taught with concept-maps; males achieve better than their female counterpart. Similarly contradicting the findings of Joy (2015) who pointed out that female students achieved higher than the male students in her study. Also Nwona and Akogun (2015) found that female students performed better than their male counterparts in science technology and mathematics. However, the findings of this study is congruent to the findings of Sakiyo and Waziri (2015), Joda (2018) in their result, concept-map has a significant effect on Biology students' academic achievement and no significant effect on their gender. In other words the teaching strategy does not differentiate between genders in respect of academic achievement. It also agrees with the findings of Ahmed, Shittu, Yahaya and Dada (2021), who investigated the

effects of Concept-mapping instructional strategy on senior secondary school students' achievement and retention in biology. They found that the concept-mapping group performed better than the group taught with lecture method and there was no gender influence on students' achievement.

The effect of gender on students' academic achievement when taught with Vee-mapping teaching strategy agrees with the findings of Njue and Magana (2016) in their study on the effects Vee-mapping teaching approach on students' achievement in Biology based on gender. It was found that Vee-mapping teaching Approach (Vee-Heuristics) significantly facilitated Students' achievements in biology compared to lecture method regardless of gender. It is also on the same page with the findings of, Musa, Bernadette and Veronica, (2018), in which there is significant main effect on academic achievement and no significant differences between the performance of male and female students when taught with Vee-mapping teaching strategy. However, it disagrees with a similar study on chemistry students by Yerima, Muazu and Hamidu (2017), in which male students outperformed the female students when taught with Vee-mapping teaching strategy

The inference one could draw from the result of this study is that, given equal opportunity in the learning process, and when taught with these strategies (concept-mapping and Vee-mapping) gender has no influence on biology student's academic achievement. This means that the two teaching strategies are both gender friendly.

RECOMMENDATIONS

Based on the findings of this study the following could be recommended;

1. There is need to introduce concept-mapping and vee-mapping instructional strategies in pre-service science education programs in tertiary institutions.
2. Curriculum designers, teachers in active service and other stake holders in education should adapt the use of Concept-mapping and Vee-mapping teaching

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- strategies in teaching Biology in our schools.
- Teachers should be involved in workshops so as to train them on how to use these teaching approaches to move them towards perfecting the skills of exploring meaningful learning by actively involving their students in the learning process.
 - Being gender friendly teaching strategies their use should be encouraged in mix classrooms in our schools.
 - Educational book authors should design the contents of their books in line with the use of these strategies

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