

Effects of Concept Mapping Strategy on Secondary School Physics Students Achievement in Akwanga, Nasarawa State, Nigeria

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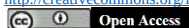
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ABSTRACT

This paper examined the effectiveness of concept-mapping strategy on secondary school physics' students' achievement in physics. The population of the study comprised of all Physics students in secondary schools in Akwanga Local Government Area, Nasarawa State, Nigeria. A sample of 86 (47 Male students and 39 Female students) senior secondary school II (S.S. II) Physics students were selected using purposive sampling technique. A non-equivalent quasi-experimental pre-test and post-test design was adopted for the study. The experimental group was assigned 44 students while the Control group was assigned 42 students. A 25-items Physics Achievement Test (PAT) was constructed based on the aspects of the topic "electromagnetism" in physics. The instrument was validated by 3 experts in physics education, measurement and evaluation. The instrument was pilot tested and the reliability index obtained was 0.76 using Cronbach Alpha method. The data were analyzed with mean, standard deviation and t-test analysis. The results of the study revealed that there was significant difference that exist between the pretest and post-test mean scores of the experimental group; there was significant difference between the students' achievement taught with concept mapping and lecture method; there was no significant difference between male and female students' achievement taught with concept mapping strategy. The study recommended that physics teachers should adopt concept-mapping strategy of teaching to enhance students' achievement; teachers should actively engage students in teaching and learning process to improve on their meaningful learning through the mapping of concepts.

Introduction

Education is the tool for developing the individual for economic, political, scientific and technology development of a nation. The government has transformed the educational system of the nation through various reforms to meet up to the best global practice. Nigerian government has explicit policy directive on integrating Information Communication and Technology (ICT) into all level of education and curriculum harmonization policies for the Core Curriculum Minimum Standard spearheaded by National Universities Commission (NUC) and National Board of Technical Education (NBTE) (Emeka & Okafor, 2024; Lawal & Bello, 2025). Science education remains a vital aspect of the educational program in schools that has great benefits to the learners toward acquiring basic concepts and skills for self-empowerment and for the required manpower. The knowledge of science has empowered students with scientific literacy, critical thinking, problem-solving abilities, and innovations which are tools for economic growth, environmental conservation, and social equity (UNESCO, 2019). Science has been responsible for the rapid development in all sectors of the economy and has aid in making life more meaningful to the citizens.

Teaching and learning of Physics in schools is critical to attaining the objectives of physics. Secondary school Physics is the foundation of acquiring the basic concepts and skills required by learners as prescribed in the Physics curriculum. The knowledge of Physics acquired by students are relevant for everyday life and serves as fundamental for further studies. Students' knowledge of Physics is found to be applicable in everyday life and in troubleshooting devices such electronics, plumbing, power outlet, household energy, sports biomechanics and serve as an indispensable prerequisite for admission and success in competitive medicine, Physics, engineering and science courses (Okonkwo & Peterson, 2024; Rahman & De Vries, 2025). The general objectives of secondary school Physics as

stated in the curriculum are to provide students with fundamental literacy for efficient living in the society, acquire basic concepts and principles of Physics as preparation for further studies, and to obtain essential skills and attitude as preparation for technological application of Physics among others (FGN, 2014). In spite of these lofty objectives of Physics to the development of the students, they have challenges in comprehending concepts and skills in Physics. This has result to students' misconceptions in the subject which has led to their under-achievement. Consequently, most students regard the subject as difficult due to misconceptions and inappropriate teaching method of teachers. Okafor and Nwosu (2024) confirmed that physics is widely regarded as difficult because of students' misconception and too much mathematical application.

The challenges students encounter in Physics are attributed to the teaching method applied by teachers that has not been effective in students' learning and achievement of the subject. Agboghroma (2015) observed that students' poor achievement in Physics is as a result of misconception in Physics which is linked to the lecture method of teaching that emphasizes rote memorization over hands-on and real-world application. Moreover, students have been encountering challenges in understanding of difficult and abstract concepts in Physics which affects their achievement as noted by researchers. Akango, Nwana and Obo (2020) reported that physics students perceived difficult concepts to involve heat, electromagnetism, energy, waves, electricity, pressure, and simple harmonic motion due to their abstract nature. Conventional teaching method such as the lecture method, which is teacher-centered is commonly used by teachers, do not help in enhancing students' understanding of difficult concepts and hence affects their achievement. Afolabi and Olufunmini (2023) noted that the lecture method of teaching Physics has result to students' poor comprehension of concepts and weak problem-solving. This teacher-centered instructional approach has contributed to students' misconception in physics. Teachers' use of this approach has limited students' opportunities for generating explanations, peer-discussion, and hands-on exploration of abstract phenomena which has left students to passive recipient of knowledge, rote-memorization and perpetual misconception (Adebayo & Sharma, 2023; Nwosu & Greene, 2025). In order to enhance students' understanding of difficult and abstract concepts in physics and improve their achievement, teachers should resolve to adopting innovative strategy such as the concept mapping strategy.

Concept mapping strategy has been useful in teaching at all levels of education at schools. The main objective of the use of concept map in teaching and learning is to enhance meaningful learning. Bressington et al. (2022) asserts that concept mapping as a pedagogical tool, its primary objective is to transit the learners from passive, rote-based acquisition to active meaningful learning. The goal of education is to bring about meaningful learning through shared meaning between the teacher and students. The use of the concept mapping strategy is based on student-centered approach in the process of knowledge construction, rather than passive recipients of knowledge as taught by many teachers. Lyimo, Mbua & Ogoti (2025), found that the use of concept mapping in teaching has enhanced secondary school students' critical thinking, helping them engage with abstract concepts and skills which enhance their capacity for problem-solving and application to real-life scenario. Concept mapping has served as a core element for linking together other concepts, sub-concepts, and other instructional ideas. The teacher's use of concept mapping strategy in teaching has improve the quality of students' content-area understanding. Srivastava, Srivastava & Chandrasekharan (2020), revealed that the quality of students' concept map depends on the teacher's use of the strategy to build it, that requires supporting students working memory of supplementary role of working space. Teaching with concept mapping implies identifying the structure of how the concepts are linked to one another and their directions to pave way for meaningful learning to occur. Ifenthaler and Seel (2022) identify the graphical structure of the concept maps as how concepts are paired with directional or bidirectional links depicting sequential, casual and associative relationship. The effective mapping of the concepts by teachers helps make learning to be meaningful as students view how concepts are sequential placed and linked to one another as explanation follows up.

The review of studies on the effect of Concept-mapping strategy on students' achievements has been reported. The findings of some prior studies related to this study are either similar or in contrast. Omeodu (2018), investigated the effect of Concept mapping in teaching physics in senior secondary schools in Portharcourt, Rivers state, Nigeria. The finding of the study reveals that students taught

physics with concept-mapping perform significantly better than those taught with the conventional teaching method. Also, the study found that there was no significant difference between male and female students taught with concept-mapping. In another study carried out by Ngaine (2021), on the effectiveness of experiential concept-mapping teaching and learning strategy on achievement and attitude in physics by secondary school students in Maara, Subcounty, Kenya. The result of the study indicates that students who were exposed to experiential concept-mapping strategy perform significantly better than those students who were taught with conventional teaching method. Another study conducted by Jena (2021) who investigated the effectiveness of concept mapping strategy on learning achievement in physical science of secondary school students in Jagatsinghpur district, Odisha, Kenya. Result of the study shows that concept mapping strategy has significant effect on students' learning achievement than the traditional teaching method. Also, no significant difference was found between the learning achievement of male and female students taught with concept-mapping strategy.

The poor achievement of students in physics at the secondary school as a result of misconception has been a thing of concern. Students' poor comprehension of concepts due to inappropriate teaching method has result to poor achievement in schools. The students' rate of poor performance at secondary school certificate examination have been reported. The Chief Examiner's report of WAEC has indicated that students exhibit poor understanding of some topics like semiconductor, projectile motion, radioactivity and inability to handle computational and numerical problems in Physics (West Africa Examination Council, 2020). These weakness encounter by students reflect both conceptual misconceptions and deficient problem-solving skills in applying Mathematics to Physics contexts. This situation has instigated the researcher to investigate the effectiveness of concept mapping strategy on students' academic achievement in secondary school Physics in Akwanga Local Government Area of Nasarawa State.

Statement of Problem

The performance of secondary school students in physics has been a thing of concern to physics teachers, principals and parents. Physics students encounter challenges in learning of difficult and abstract concepts in physics which is the basis for their achievement. This problem is attributed to the inappropriate teaching methods apply by physics teachers. The lecture method of teaching physics which is found to dominate physics classroom is characterized by teacher-centeredness, rote memorization and passive learning of physics. This has led to students' misconception, poor understanding of physics and inability in problem-solving in the subject. Moreover, this situation has made students to perform poorly in the subject. Teaching strategy such as concept mapping strategy has been found to be effective in enhancing students' meaningful learning because it involves students' active participation in building their knowledge with mapping concepts. In order to enhance students' meaningful learning in Physics of difficult and abstract concepts that would enhance their achievement in the subject, there is the need to apply concept map strategy. Therefore, this study intends to investigate the effectiveness of concept mapping strategy on secondary school students' achievement in Physics in the concept of electromagnetism in Akwanga Local Government Area of Nasarawa State.

Objectives of the study

The following were the objectives of the study:

- (1) To compare between the pre-test and post-test scores of Physics students' achievement taught with concept mapping strategy.
- (2) To compare the difference in academic achievement of Physics students taught with concept mapping strategy and lecture method.
- (3) To compare the difference in academic achievement between male and female Physics students taught with concept mapping strategy.

Significance of the Study

The significance of the study in a broader sense is to widen the scope of knowledge in teaching and learning of physics. In a more specific terms, the significance are as following:

- (1) The findings of the study would make Physics teacher see the relevance of the use of concept mapping strategy to enhance students meaningful learning of difficult and abstract concepts in Physics to improve their achievement. This will make them to adopt the concept mapping strategy in teaching Physics.

(2) The outcome of the study would immensely assist students in building their knowledge and skills in Physics through the mapping of concepts and linking of concepts for meaningful learning which is the main objective of secondary school Physics. This makes students' learning to be meaningful and improve their performance.

(3) Curriculum planner may find the outcome of this study relevant by including concept map strategy in physics curriculum for the teaching Physics.

Research Questions

The research questions that guide the study are as follows:

(1) What is the pre-test and post-test mean scores of Physics students' achievement taught with concept mapping strategy?

(2) What is the mean difference in the academic achievement of physics students taught with concept mapping strategy and lecture method?

(3) What is the mean difference that exist between the academic achievement of male and female Physics students taught with concept mapping strategy.

Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

Ho₁: There is no significant difference between the pre-test and post-test mean scores of Physics students taught in the experimental group.

Ho₂: There is no significant difference in the academic achievement of Physics students taught with Concept mapping strategy and lecture method.

Ho₃: There is no significant difference in the academic achievement between male and Female Physics students taught with Concept mapping strategy.

Methodology

The research design adopted for this study are Pre-test, Post-test control group quasi-experimental design. The study involves experimental group and control group so as to determine the effect of concept mapping strategy on students' academic achievement in Physics over the lecture method of teaching. The target population of the study consist of all SS2 Physics students selected from 2 Science Secondary Schools in Akwanga local government area of Nasarawa state. A simple random sampling and Purposive sampling were employed to obtain 2 science secondary schools and a total sample of 86 Physics students of which 47 students are Male students and 39 students are female. The intact classes from each participating schools were randomly assigned to concept-mapping strategy group and lecture method group respectively. 44 students were assigned to experimental group while 42 students were assigned to the control group.

In order to account for any possible pre-existing difference in overall ability between the treatment group, the Pre-test (Pre-Physics Achievement Test) was used as covariate measure. Teacher quality variable was control for both group, students were taught by their regular school Physics teachers. The teachers for the experimental group were trained for three days on how to conduct the concept-mapping strategy using the topic electromagnetism while teachers for the control group were also trained on the lecture method using the same topic, electromagnetism. Both groups were taught electromagnetism using the same content outline, but students in concept-mapping group were learning with concept-maps while the students in the lecture method group were learning with normal lesson notes deliver by the teacher during presentation.

The instrument used to measure students' achievement was designed by researcher from items related to the topic under electromagnetism from the SS 2 physics textbook. The instrument referred to as Physics Achievement Test (PAT) consisted of 25-items which are multiple-choice questions. Each question correctly answered has one point score. Content validity of the instrument was verified by three experts in both Physics education, and in measurement and evaluation. The instrument was pilot tested to establish reliability coefficient in a school not selected to participate in the study. The internal consistency of the pilot test scores was obtained by subjected it to Cronbach Alpha method. The reliability index of 0.76 Alpha coefficient was obtained. This is considered good internal consistency. The test was administered to both groups at the end of the instructional activity.

Results

Research question 1: What are the pre-test and post-test mean scores of Physics students' achievement taught with concept mapping strategy?

Table 1

Mean and Standard Deviation of Pre-test and Post-test of Students' Achievement Taught Physics with Concept Mapping Strategy.

Teaching Strategy	No	Pre-test		Post-test		Mean difference
		Mean	S.D	Mean	S.D	
Concept Mapping	44	49.50	8.617	57.57	9.902	8.07

Table 1 revealed that the pretest mean score of the experimental group taught with concept mapping is 49.50 while the post-test mean score was 57.57. In the experimental group, the post-test mean score of the concept mapping strategy is greater than the pretest means score with the mean difference of 8.07. This implies that Physics students' academic achievement has increased due to the concept mapping instructional strategy.

Hypothesis One

H₀₁: There is no significance difference between the pretest and post-test mean scores of students taught physics in the experimental group.

Table 2

Paired t-test Analysis on Pretest Mean Score and Post-test Mean Score of Students Taught Physics in the experimental group.

Scores		N	X	S.D	df	t-cal	t-critical	Decision
Pair	post-test	44	57.57	9.40	43	6.05	2.02	NS
	Pre-test	44	49.50	8.62				

NS= Not significant at $P > 0.05$ alpha level.

Table 2 presents the pair t-test analysis on the pretest and post-test mean scores of students in the experimental group. The mean score of the pretest and post-test was calculated to ascertain the difference that exist after the experiment was conducted. However, the paired t-test conducted on both pre-test and post-test means yielded a t-value of 6.05 which is greater than the t-critical value of 1.99. Therefore, the null hypothesis is rejected. This implies that there is significant difference that exist between the pretest and post-test mean scores of the experimental group. That means there is increase in achievement of students due to the administered treatment of the concept mapping strategy.

Research question 2: What is the mean scores difference in the academic achievement of students taught Physics with concept mapping strategy and lecture method?

Table 3

Mean and Standard Deviation of Pre-test and Post-test of Students' Achievement Taught Physics with Concept Mapping Strategy and Lecture Method?

Teaching strategy	No	Pre-test		Post-test		Mean difference
		Mean	S.D	Mean	S.D	
Concept Mapping	44	49.50	8.617	57.57	9.902	8.07
Lecture Method	42	45.90	11.131	50.57	11.180	4.67
Difference		3.60		7.00		3.40

Table 3 revealed that the concept mapping strategy has the pretest mean scores of 49.50 and post-test mean score of 57.57 with mean difference of 8.07 whereas the pre-test mean scores of the lecture method was 45.90 and post-test mean scores of 50.57 with mean difference of 4.67. Also, the mean difference that exist between the pre-test and post-test mean scores of both methods was 3.40. In order to ensure that the initial difference of the prior knowledge does not affect the result, a pretest which was conducted between the two methods shows a very low value of 3.60. It is therefore clear that concept mapping instructional strategy enhanced students' achievement more than the lecture method.

Hypothesis Two

H02: There is no significant difference in the academic achievement of students taught Physics with concept mapping strategy and lecture method.

Table 4

Independent t-Test Analysis on Post-test Scores of Students' Achievement Taught Physics with Concept Mapping Strategy and Lecture Method.

Teaching Method		N	X	S.D	df	t-cal	t-critical	Decision
Posttest Physics Score	Concept mapping	44	57.57	9.40	84	3.15	1.99	NS
	Lecture method	42	50.57	11.18				

NS = Not Significant at $P > 0.05$ alpha level.

Table 4 presents the independent t-Test analysis on the academic achievement of students taught physics with concept mapping and lecture method. The table shows that the t-value (3.15) is greater than the t-crit. (1.99). Therefore, the hypothesis was rejected. This implies that there is significant difference between students who were taught Physics with concept mapping strategy and those who were taught with lecture method. The students taught Physics with concept mapping perform better than those taught with lecture method

Research question 3: What is the mean difference that exist between the academic achievement of male and female students taught with concept mapping strategy.

Table 5

Mean and Standard Deviation of Post-test of Male and Female Students' achievement Taught Physics with Concept mapping Strategy.

Teaching Method	Group	No	Post-test	Mean difference
Mean				
S.D				
Concept Mapping	Male EG	24	58.67	10.09
Concept Mapping	Female EG	20	56.25	8.57

EG = Experimental Group

Table 5 presents the gender performance of the experimental group who were taught with concept mapping strategy. This is to investigate whether concept mapping instructional strategy is gender sensitive. Male students had a mean score of 58.67 and female students had a mean score of 56.25. The mean difference that exists between the male and female performance was 2.42. This shows that male students perform slightly better than female students when taught with concept mapping strategy.

Hypothesis Three

H03: There is no significant difference in the academic achievement of male and female students taught Physics with concept mapping strategy.

Table 6

Independent t-Test Analysis on Post-test Scores of Academic Achievements of Male and Female Students Taught Physics with Concept Mapping Strategy.

	Gender	N	X	S.D	df	t-cal	t-critical	Decision
Posttest Physics Score	Male	24	58.67	10.09	42	0.85	2.02	S
	Female	20	56.25	8.57				

S = Significant at 0.05 alpha level

Table 6 presents that the independent t-Test analysis on the academic achievement of male and female students taught Physics with concept mapping strategy. The table shows that the t-value (0.846) is less than the critical t-value (2.018). Therefore, the null hypothesis is accepted, that is no significant difference in the academic achievement of male and female students taught physics with concept-mapping strategy. This implies that gender did not significantly influence achievement based on concept-mapping instructional strategy.

Discussion

The result of the study as presented in Table 2, shows that there is significance difference between the pre-test and post-test mean scores of students in the experimental group. This means that the performance of students in the experimental group when taught with concept mapping strategy (post-test) is higher than that of the same students of their prior knowledge of physics (pretest score). This study is in line with the findings of Omodu (2018) that there is significance difference between the pretest scores and post-test scores of students in the experimental group.

The result from Table 4 clearly indicates that there is significant difference between the academic achievement of students taught physics with concept mapping strategy and lecture method. This might be due to the fact that concept mapping strategy is student-centered and activity oriented, where students are involved in meaningful learning with concept maps unlike the lecture method. The result agrees with the previous study of Ngaine (2021) whose research revealed that students taught using concept mapping strategy perform better than those students taught with lecture method.

The finding of the study in Table 6, reveals that academic achievement of male and female students taught physics with concept mapping strategy is insignificant. This implies that both male and female students have similar performance when taught with concept mapping strategy. This result agrees with the previous study of Jena (2021) whose finding reveals that the academic achievement of male and female students taught with concept-mapping strategy does not differs.

Conclusion

This study has revealed the effects of concept mapping instructional strategy on the students' academic achievement in Secondary School Physics. The impact of the concept mapping strategy was compared with the lecture method to determine their effectiveness on students' Performance. Based on the finding of the study, concept mapping strategy of teaching enhance students' achievement in physics as compared to their prior knowledge. This is evidence in the significant achievement of students taught with concept mapping strategy than those taught with lecture method. Also, concept mapping strategy is not gender sensitive, that is both Male and Female students' achievement is not determine by concept mapping strategy.

The study investigated the effectiveness of concept mapping strategy on Physics students' academic achievement in secondary schools in Akwanga Local government Area of Nasarawa State. This study can be replicated in other science subjects and in different geographical location. Also, the effectiveness of concept mapping strategy on students' academic achievement can be compared with other teaching methods to ascertain its effectiveness.

Recommendation

The following recommendations were made based on the finding of the study.

1. Physics teachers should imbibe concept-mapping strategy in teaching of Physics so as to enhance students' comprehension, identification of relationship between concepts and creativity.
2. Physics teachers should actively engage students in the teaching process in building their knowledge and skills through concept mapping to improve their misconceptions in Physics.
3. Schools should train teachers through workshops and seminar on the use of concept-mapping strategy in teaching for effective teaching and to enhance students' achievement. This could be done through organizing workshop or seminar on the use of concept map strategy.
4. Students should be encouraged to draw maps of concepts of topic being taught after teaching and be able how the concepts relate. This will help them in meaningful learning, building of knowledge and retention.

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