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Effect of Concept Mapping Instructional Strategy on Secondary School Students' Achievement in Physics

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Abstract
This study investigated the Effect of Concept Mapping Instructional Strategy (CMIS) on Senior Secondary two (SS II) Students' Achievement in Physics. The purpose was to ascertain how impactful concept mapping as an instructional strategy can improve students understanding of physics concepts. A quasi-experiment of the pre-test, post-test non-equivalence control group research design was adopted for the study. The population comprised Senior secondary two (SS 2) students numbering 10,206 from all the 78 public secondary schools in Abakaliki education zone of Ebonyi State, Nigeria. The sample of the study comprised 93 students (54 males and 39 females) drawn from 4 randomly sample schools from the four local government areas in the zone. Physics Achievement Test (PAT) with reliability coefficients of 0.75 was used as instruments for data collection while Mean and standard deviation were used to answer the research questions and analysis of covariance (ANCOVA) was used to test the hypotheses at 95% confidence level. The results revealed that CMIS significantly enhanced the mean achievement scores of the students in physics more than the conventional chalk and talk method. Findings further revealed that there is no significant difference between the mean achievement scores of male and female students taught physics using CMIS. While the interaction between the methods and gender on the students mean achievement scores in physics was not statistically significant. Based on the findings of the study, it was recommended among others that physics teachers should prioritise the use of CMIS since it has been proved to have a significant positive effect on the academic achievement of secondary school students in physics.
Key words: Concept mapping instructional strategy, physics and achievement in physics.
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INTRODUCTION

Globally, quality education has been a fundamental instrument for the advancement of human and national development. Owing to this reality of the gains inherent in quality education for scientific and technological development, nations that crave for sustainable development are prioritizing huge investment in education so as to be in the league of the global quest for sustainable development. In particular, science and technology have proven useful in man's struggle to advance his environment and build a sustainable world. Specifically, Abamba and Esiekpe (2021), Akanbi, Olayinka, Omosero and Mohammed (2021), Agu and Iyam (2020) assert that effects of education on national development emanate basically from the areas of science and technology. In recent times, most developing nations are making frantic efforts to improve on the study of science and other related subjects in their schools (Uzobuike & Okoli, 2020). In Nigeria for example, the National Policy on Education stipulates that admission into the nation's tertiary institutions should be based on 60:40 ratio for science and arts related courses respectively (Federal Government of Nigeria – FGN, 2013). Furthermore, the 9-3-4 system of education in Nigeria which focuses on self-reliance and sustainable national development is built around science and technology. At the secondary level of education in Nigeria, one of the science subjects projected to help develop individuals who will contribute in scientific and technological breakthrough of the nation is physics.

Physics being the study of matter, energy and their interactions is an international enterprise that plays a key role in the future progress of humankind (Uzobuike & Okoli, 2020). It generates fundamental knowledge needed for the future technological advances that will continue to drive the economic engines of the world. It contributes to the technological infrastructure and provides trained personnel needed to take advantage of scientific advances and discoveries (Akanbi, Olayinka, Omosero and Mohammed, 2021). Furthermore, physics helps humanity to

understand the laws and rules that govern the physical world (Abamba & Esiekpe, 2021). Although not every student will grow up and study physics on a deeper level, but everyone uses basic physics concept to navigate everyday life. Similarly, physics extends well into everyday life, describing the motion, forces and energy of ordinary experience (Ogunleye & Ojekwu, 2019). In actions such as walking, driving a car or using a phone, physics is at work. Equally, for everyday living, all the technologies that might be taken for granted exploit the rules of physics (Oluwatosin & Bello, 2014). The knowledge of physics can also be applied in the fields of agriculture, automobile, electrical and electronics, civil works, among others.

Furthermore, the support of physics education and research in all countries is important because:

i. Physics is an exciting intellectual adventure that inspires young people and expands the frontiers of our knowledge about nature.
ii. Physics generates fundamental knowledge needed for the future technological advances that will continue to drive the economic engines of the world.
iii. Physics contributes to the technological infrastructure and provides trained personnel needed to take advantage of scientific advances and discoveries.
iv. Physics is an important element in the education of chemists, engineers and computer scientists, as well as practitioners of the other physical and biomedical sciences.
v. Physics extends and enhances our understanding of other disciplines, such as the earth, agricultural, chemical, biological, and environmental sciences, plus astrophysics and cosmology - subjects of substantial importance to all peoples of the world.
vi. Physics improves our quality of life by providing the basic understanding necessary for developing new instrumentation and techniques for medical applications, such as computer tomography, magnetic resonance imaging, positron emission tomography, ultrasonic imaging, and laser surgery (Khan & Panth, 2017; Hall, 2015).

The preceding implies that no nation can develop scientifically and technologically without proper foundations in school physics (Abamba & Esiekpe, 2021). Therefore, physics serves as a means of sharpening man's reasoning ability and developing man's personality. Hence, physics is indispensable in nation building. Regrettably, research reports (Agu & Iyamu, 2020; Uzobuike & Okoli, 2020;) shows that Nigeria secondary school students' achievement in physics especially in certificate examination like the West African Senior School Certificate Examination (WASSCE) is a course of worry to all stakeholders in the education system – parents, teachers, school authorities, government and employers of labour. Reports of the WAEC Chief Examiners Report in Physics reveal clearly that students' poor achievement in physics is traceable to their weakness in thermal energy which incidentally forms the bulk of the questions in all physics papers (WAEC Chief Examiners Reports 2016, 2017, 2018, 2019 & 2020). According to the Chief Examiners reports the students' weaknesses were manifested in their inability to attempt most questions on thermal energy and poor illustrations in questions drawn from thermal energy. For example, in the years 2015, 2016 and 2017 showed that 36.54%, 41.90% and 43.40% of the students had credits and above in physics while 63.46%, 58.10% and 56.60% respectively had below credit pass (see table 1).

Table 1: Students achievement in May/June 2010 – 2017 WASSCE Physics in Nigeria

Year	Total Entry	Pass Grade Levels		Fail Grade Levels	
		(A1 – C6)	Percentage (%)	(D7 – F9)	(%)
2010	387, 380	148, 599	38.36%	238, 781	61.64%
2011	374, 958	162, 769	43.41%	212, 189	56. 59%
2012	386, 449	190, 210	49.22%	196, 239	50.78%
2013	423, 146	153, 137	36. 19%	270, 009	63.81%
2014	402, 228	140, 056	34. 82%	262, 172	65.18%
2015	398, 870	145, 747	36. 54%	253, 123	63.46%
2016	416, 580	174, 432	41.9%	242, 148	58.1%
2017	422, 110	183, 020	43.4%	239, 090	56.6%

Source: Statistics Department of the WASSCE Office Yaba, Lagos (2018).

Specifically, it was contained in the chief examiners report of 2020 that most candidates had difficulty in solving problems in mechanics, sound and heat, could not give the reason for using steal as a compass needle and iron as a core of electromagnets, failed to record length measured with the meter rule to one decimal place in

centimetres, were unable to make simple deductions from the graph and were unable to plot points correctly to the accuracy of chosen scales (WAEC, 2020). In 2019, the chief examiners reported that candidates performed woefully in physics in; the use of odd scales, failure to record values to the correct number of decimal places, dimensional analysis and the concept of terminal velocity (WAEC, 2019). In 2018, it was also contained in the report of the chief examiners that candidates performed on average but failed woefully in following topics; heat transfer, semi-conductors and nuclear physics (WAEC, 2018). More so, in 2017, candidates were reported to have performed woefully in the following topics; temperature calculations, optics, current electricity and motion in inclined plane. While in 2016, the response of most candidates in Physics 2 and 3 showed that they lacked in-depth knowledge of scientific concepts.

However there are many factors responsible for student's poor achievement in Physic. These factors include; poor primary school background (Deka, Dhanpa & Ramu, 2018), lack of interest (Ogunleye & Ojekwu, 2019), poor teaching and learning environment (Alomani, 2019) and ineffective method of instruction (Duliyemi & Babafemi, 2019). Moreover, the WAEC Chief Examiner Report (2016-2020) emphasized on the need to improve teaching methods to enhance academic achievement of students in physics. In support of the observations of the WAEC Chief Examiners' Report, studies by Agu and Iyamu (2020), Uzobuike and Okoli (2020) showed that effective teaching method enhances students' achievement in sciences including physics. These findings recommended further studies to clarify the issues related to achievement as it concerns instructional strategies used in teaching.

Furthermore, Nzeadibe (2016), revealed that the problem with respect to teaching strategies is that most teachers still believe that the most effective means of communicating knowledge is through the conventional "talk and chalk" strategy. The 'talk and chalk' as used in this context is the traditional way of imparting knowledge whereby students' participation is limited during teaching process. Hence, it is a teacher-centred strategy. More importantly, the conventional teaching approach has not been able to meet learners' needs as mass failure of students in physics is a reoccurring issue. The WAEC Chief Examiners Reports indicated that constant use of conventional teaching strategies contributed to students' poor achievement and retention in some physics topics such as thermal energy, radioactivity and electrolysis. More so, poor students' achievement in physics at the Senior Secondary Certificate Examination (SSCE) is reported to be attributed to difficult topics including thermal energy, radioactivity and electrolysis (Abamba & Esiekpe, 2021; Agu & Iyamu, 2020). The reasons why most physics students fail questions in aforementioned topics may be because it contains mathematical concepts which require background knowledge of mathematics principles to solve them. Apart from the problem of mathematical physics tasks, the lack of the use of modelling to demonstrate experiment in the classroom may also affect students' cognition and achievement.

In order to ensure that students' excel in physics, over dependent on the use of conventional chalk and talk method by teachers should be minimized. Agu and Iyamu (2020) opine that in conventional approach to teaching, there is no teacher-student interaction as the teacher dominates all the class activities right from the beginning of the lesson to the end. Conventional method of teaching also has the attributes of brief teaching, which hinders collaborative and critical thinking that promotes reflection and metacognition. Many researchers have opined that conventional teaching method may cause students to resort to rote learning and memorization instead of reflective thinking that is more effective in enhancing their cognition and retentive ability (Ogunleye & Ojekwu, 2019). Duyilemi, Olangunju and Olamide (2014) stated that the overreliance on conventional method in the teaching of physics concepts may affect students' achievement in the subject. As a crux, Akanbi et al (2021) pointed out that for teaching and learning to be effective and impact positively on students' academic achievement, the minds of students need to be exposed to varieties of innovative teaching and learning activities that will stimulate students' mental thinking to develop their own cognition. Among the varieties of teaching strategies that enhances students' mental thinking skills that engenders improved academic achievement is concept mapping instructional strategy.

Concept mapping instructional strategy as postulated by Akanbi et al (2021) encompasses a picture presentation of concepts in a central image, where the major themes radiate from the central images as branches with a key word or image printed on an associated line of the branches. It represents a comprehensive articulators of visual presentations by combining the attributes of colour, sketch and objects to assist the learner to conceptualize ideas and understand abstract contents, while at the same time promotes learning achievement and retentive memory. Abamba and Esiekpe (2021) averts that visual learning encompasses such ideas as concept maps, mind maps and tree diagrams which basically makes use of diagrams and have been proven overtime to be an efficient teaching method. This is because these visual learning strategies present key information in graphical format thereby allowing for faster and concrete internalization of knowledge by the learners (Rajapriya & Kumar, 2017). In

describing concept mapping, Gagic, Skuban, Raduloric, Stojanovic and Gajic (2019) posit that there is widespread agreement that the adoption and proper utilization of it during instruction facilitates meaningful learning. This is based on the premise that visual stimulation (in terms of pictures, graphic items, and colour) excites the visual-spatial sketchpad in the memory, thereby enhancing students interest to understand new knowledge through the association of visual stimuli to spoken words. The use of the connected nodes creates a sub-idea, often with the use of visual elements including colours, images, words and numbers (Katcha, Orji, Ubele, Abubakar & Mohammed, 2018).

Furthermore, concept mapping basically involves the use of visual presentation where the topic or major concept is at the center of the page, while the main ideas are placed around it in a radial form with connector lines (Abbas, Eldin & Elsayed, 2018). Each of the ideas has sub-ideas that are also linked to the idea (Akba & Tagl, 2017). The rationale for such is to move ideas from the general to the specific. It also involves the deconstruction of concepts at each stage, while maintaining their connection to their subordinates (Bawaneh, 2019; Batdi, 2015). This activity is carried out with diagrams, patterns and colours in order to create a vivid and long-lasting memorable impression in the learners mind. Oluwatosin and Bello (2015) agrees that the use of the model during instruction facilitates greater understanding among the learners by enhancing their analytical and memory skills thereby ensuring retention and learning. Using concept maps also helps teachers vary their teaching methods which may be more likely to reach diverse learners (Mahasneh, 2017; Adodo, 2013). It makes the teaching-learning activity more stimulating for the teacher as well the students and enables effective knowledge construction and sharing (Paritk, 2015) and enhances creative thinking (Yoon & Kang, 2015).

Concept mapping has practical values in science education and physics teaching and learning in particular, because it helps in improving classroom efficiency, helping students to integrate scattered knowledge, stimulating students' interest in studying physics and cultivating students' divergent thinking ability (Bo-Janf & Li-Wang, 2019). Based on the teaching mode of concept mapping, it is a good instructional technique that motivates students (Kanelechi, Nwangwu & Amadi, 2018: Omeodu, 2018). It is a good means of compacting ideas and notions into a piece of paper during teaching-learning process, summarizing them into a colourful picture – the concept map (Hwang, Kuo, Chen & Ho, 2014; Tanriseven, 2014; Dhindsa & Anderson, 2011). The use of concept maps in teaching and learning process has gained prominence and showed positive results over the years. It has been applied in the teaching-learning process extensively, either as a means of note taking or teacher's summary of a particular concept to show relationships (Kenesha, Eddia & Natalie, 2016; Abdool & Cathy, 2016).

Research findings of some studies that employed concept mapping instructional strategies show that it enhances students' achievement in various subjects. For instance, Abamba and Esiekpe (2021), Akambi et al (2021), Uzobuike and Okoli (2020), Ogunleye and Ojekwu (2019), Wilson, Copeland-Solas & Guthie-Dixon (2016), Agummuo and Ifeanacho (2013) found out that students achieved higher in physics and sciences when taught using CMIS. The reason for relating CMIS to students academic achievement is that students who performed poorly in physics due to their inability to solve difficult questions may get their thinking abilities improved upon to enable them understand and solve difficult tasks. In addition, CMIS collaborative thinking between the teacher and learners which enable learners develop their mental thinking to understand difficult topics and tasks. When students are able to solve difficult tasks, their achievement in physics may be enhanced. For instance, Ibe, Nwosu, Obi and Nwoye (2016), notes that to motivate students to learn, the teachers must make physics lesson interesting, real and relevant by adopting instructional strategies that will enhance their thinking ability, allow for active students participation in lessons and using local familiar examples to illustrate physics concepts. It is in recognition of the impacts CMIS could exert on students academic achievement that this study is designed to examine its efficacy on senior secondary physics students' achievement physics.

Academic achievement is the outcome of education to which students, teachers or institutions has been able to realize their educational objectives (Nzeadibe, 2016). Achievement implies something that somebody has done successfully especially using his/her own efforts and skills (Okeke, 2016). Nwagbo (2013) described academic achievement as performance of students in school. It is the act of obtaining a result through efforts in the quality and quantity of students' work. Bitrus (2014) stated that academic achievement is a measure of knowledge gained through education process usually by test scores, grade point average or certificates. This is why some schools define this as a certain grade point average (GPA), or ranking in class attained by students. Improved students achievement may be achieved the use of innovative teaching strategies like concept mapping teaching strategies (Oluwatosin & Bello, 2015:2014). In this regard, Tariseven (2014) stated that the use of innovative teaching strategies like concept mapping may help students to develop better understanding of a subject like physics which may lead to improved performance in achievement and retentive ability.

Gender is similarly recognized to play a key impact in students' understanding of physics concepts with diverse instructional approaches because of the interaction of masculinity and feminity assigned to physical scientific subjects including physics (Umoh, 2016; Emmanuel & Samuel, 2016). In numerous domains of research, gender differences in academic achievement have been linked to interactions between learners' physical, psychological, and physiological traits, particularly the way they learn (Abamba and Esiekpe, 2021; Akanbi et al., 2021; Agu and Iyam, 2020, Oviawe, 2020; Nnorom and Erhabor, 2019). The researcher felt it was necessary to study the association between teachers' use of CMIS and secondary school students' academic achievement in physics. Although concept mapping strategy has been widely advocated and applied in sciences, arts and social sciences, its workability in physics classroom has not been subjected to wide empirical verifications irrespective of the various claims and counterclaims by researchers in the fields of physics concerning the technique. As such the workability or otherwise, of this approaches in the teaching and learning of physics in senior secondary schools in Nigeria, need to be empirically investigated.

PROBLEM STATEMENT

Despite the immense contribution of physics to scientific and technological advancement and development of the society, principals' of secondary schools, parents, physics and science teachers generally have expressed great concern regarding the continued poor achievement of students in the subject. Poor achievement in physics has caused unfulfilled dreams among students, created extra financial burden on parents resulting to low rate of scientific and technological man-power development to the nation. Incidentally WAEC Chief Examiners have traced this poor achievement in physics to outright failures and aversion for questions in thermal energy, radioactivity and electrolysis which formed a major component of physics core curriculum and question in the three physics examination papers. Evidence of poor achievement of Nigerian students in May/June WASSCE physics examinations between 2010 and 2017 as reported by the examination body is a cause for worry.

Several studies (Abamba & Esiekpe, 2021; Akanbi et al, 2021; Agu & Iyamu, 2020; Uzobuike & Okoli, 2020; Ibe & Abamuche, 2019; Ogunleye & Ojekwu, 2019; Achor, Danjuma & Orji, 2019; Okeke, 2018; Umar, Fugu & Aliyu, 2018, Khan & Panth, 2017; among others) have identified instructional approaches as a major factor responsible for the poor achievement of students in physics which revolve around poor mastery of basic thermal energy, radioactivity and electrolysis concepts. Although CMIS is pin-pointed as a viable approach for teaching physics concepts, little is known about the effect of on students' achievement in physics. It is against this premise that the major issue of academic concern for this study was to examine the effect of CMIS on the academic achievement of senior secondary school students in physics?

OBJECTIVES

1. Examine the effect of CMIS on students mean achievement scores in physics;
2. Determine the mean achievement scores of male and female students taught physics using CMIS; and
3. Examine the interaction effect of methods and gender on the mean achievement scores of students in physics.

METHODOLOGY

Quasi-experiment of the pre-test, post-test non-equivalence control group research design was adopted for the study. The choice of the design is to minimize the chances of error in the study. Consequently, intact classes of students where studied. Symbolically, the design is represented thus:

E 0_1 x 0_2

C 0_1 y 0_2

Where;
E = Experimental Group;
C = Control Group
0_1=Pre achievement test
0_2=Post achievement test
x = Concept mapping instructional strategy (CMIS)
y = Conventional talk and chalk method.

Senior secondary two (SS 2) students from all the 78 public secondary schools in Abakaliki education zone of Ebonyi State totaling 10,206 formed the population of this study. The sample of the study comprised 93 students (54 males and 39 females) drawn from 4 randomly sample schools from the four local government areas in the zone. students' in the treatment group were taught with CMIS while those in the control group were taught with conventional talk and chalk method. Physics Achievement Test (PAT) with reliability coefficients of 0.75 was

used as instruments for data collection. Test blueprint or table of specification was used to ascertain the content specifications of the question items of the PAT. Mean with standard deviation were used to answer the research questions while analysis of covariance (ANCOVA) was used to test the hypotheses at 95% confidence level.

RESULTS

Research Question 1

What is the effect of CMIS on the mean achievement scores of students in physics?
For this research question, data obtained PAT on the achievement of the students in the treatment and control groups were used to answer the research question. Mean for pre and post tests were adjusted statistically in the analysis to take care of the initial equivalence of the research subjects. Summary of result of data analysis is presented in table 2.

Table 2: summary of mean achievement scores of students taught physics using concept mapping strategy and those taught with the conventional method

Group	Mean	Standard deviation	N
Experimental (Concept Mapping)	72.28	20.57	50
Control (Chalk and Talk)	52.47	6.99	43

Summary of result in Table2 showed that students taught physics using the CMIS had a higher mean achievement score (72.28) than their counterparts taught with the conventional talk and chalk approach (52.47). This implies that CMIS enhanced the achievement of students in physics more than those exposed to conventional approach.

Research Question 2

What is the effect of CMIS on the mean achievement scores of male and female students in physics?
For this research question, data obtained with PAT on the achievement of the students in the treatment control group was used to answer the research question. Mean for pre and post tests were adjusted statistically in the analysis to take care of the initial equivalence of the research subjects. Summary of result of data analysis is presented in table 3.

Table 3: summary of mean achievement scores of male and female students taught physics using concept mapping instructional strategy

Gender	Mean	Standard deviation	N
Male	65.33	18.92	54
Female	60.05	17.96	39

Summary of result in Table3 showed that male students taught physics using the CMIS had a higher mean achievement score (65.18) than their female counterparts taught with the same strategy (60.05). This implies that CMIS enhanced the achievement of male students in physics more than their female counterparts exposed to same strategy.

Research question 3

What is the interaction effect of methods and gender on the mean achievement scores of students in physics?
Adjusted mean for the two levels of gender that were subjected to concept mapping instructional strategy and those subjected to the conventional chalk and talk method were used to access the interaction. Summary of result is presented in table 4.

Table 4: summary of interaction between gender and teaching strategies on students mean achievement scores in physics

Gender group	Mean for Treatment Group	Mean for Control Group
Males	77.17	51.60
Females	65.52	53.67

Summary of result presented in table4 reveal clearly that there is no interaction effect of gender and teaching methods on students achievement scores in physics.

Hypotheses

Ho_1: There is no significant effect of CMIS on the mean achievement scores of students in physics.
Ho_3: There is significant interaction between methods and gender on students mean achievement scores in physics.

Table 5: Analysis of co-variance for students' overall physics achievement scores by teaching methods and by gender/teaching methods (interaction)

Source	Type III Sum of Squares	df	Mean Square	F	Significance
Corrected Model	18885.119[a]	4	4721.280	32.037	.000
Intercept	4345.474	1	4345.474	29.487	.000
Pretest	8110.796	1	8110.796	55.037	.000
Method	**8561.672**	**1**	**8561.672**	**58.096**	**.000**
Gender	202.043	1	202.043	1.371	.245
Method*Gender	**654.364**	**1**	**654.364**	**4.440**	**.380**
Error	12968.580	88	147.370		
Total	402350.000	93			
Corrected Total	31853.699	92			

For hypothesis 1, the ANCOVA table5 shows the sig. value of 0.000 is less than 0.05. The decision rule is to reject the null hypothesis when the sig. value is less than alpha value of 0.05. Since the sig. value is less than 0.05, the null hypothesis was rejected. The researcher concludes that there is a significant difference in the mean achievement scores of students taught physics using CMIS and those taught physics using conventional chalk and talk method. For hypothesis 3, result in table5 revealed that for two-way interaction, F.Sig. is 0.380 which is greater than 0.05. The researcher therefore, upheld the null hypothesis and concludes that there is no significant interaction between gender and teaching strategies on students' mean achievement scores in physics.

H_{O3}: There is no significant difference in the mean achievement scores of male and female students taught physics using CMIS.

Table 6: Analysis of co-variance for male and female students' overall physics achievement scores by gender

Source	Type III Sum of Squares	Df	Mean Square	F	Significance
Corrected Model	11080.912[a]	2	5540.456	26.998	.000
Intercept	3754.337	1	3754.337	18.295	.000
Pretest	9428.208	1	9428.208	45.943	.000
Gender	**702.281**	**1**	**702.281**	**3.422**	**.071**
Error	9645.168	47	205.216		
Total	281946.000	50			
Corrected Total	20726.080	49			

Summary of result on Table6 shows that the sig. value of 0.071 is greater than 0.05. The decision rule is to uphold the null hypothesis when the sig. value is greater than alpha value of 0.05. Since the sig. value is greater than 0.05, the null hypothesis was upheld. The researcher concludes that there is no significant difference in the mean achievement scores of male and female students taught physics using mind mapping instructional strategy. This implies that mind mapping instructional strategy enhanced the academic achievement of male and female students' without a significant difference.

DISCUSSIONS

Findings of the study as evident in Table2 revealed that students who were exposed to CMIS had higher mean achievement score than those who were exposed to conventional chalk and talk method. Equally, there was a significance difference of in the mean achievement scores of the students exposed to CMIS and those who were exposed to the conventional approach as evident in table8. This implies that through CMIS, secondary school students' academic achievement in physics can be improved. The findings is validated by Abamba et al (2020) who compared the effects of concept mapping and mind mapping instructional methods and found that they significantly improved students achievement more than the conventional approach. Equally, the findings is reinforced in Oguleye and Ojekwu (2019) who examined the effect of mind mapping instructional approach and gender on students basic science achievement and found out that the method significantly enhanced students achievement in basic science more than the conventional method. Further, the study aligns with that of Kanelechi et al (2018) who examined the effect of mind mapping instructional approach on secondary school students' achievement in physics and reported that it significantly enhanced achievement more than the conventional method. Consequently, it is imperative that CMIS be prioritised by physics teachers as it has been proven empirically in this study and other related studies to enhance both achievement and retentive ability of students in physics and sciences generally.

Result of analysis in table3 showed that male students taught physics using CMIS had higher mean achievement score than their female counterparts taught with the same method. However, there was no significant difference

in the mean achievement of students of both gender as evident in table 6. The finding is line with that of Abamba et al (2020) who recorded no significant difference in the mean achievement scores of male and female students taught radioactivity and electrolysis using concept mapping and mind mapping instructional strategies. However, the finding disagrees with that of Bawaneh (2019) who reported a significant difference in the mean achievement of male and female students taught electric energy concept using CMIS. Contrarily, Kanelechi et al (2019) found that mind mapping instructional approach had no differential effect on the mean achievement of students in physics. Considering disagreeing results by different researchers on the effect of concept/mind mapping on students' achievement in physics and other science subjects, the findings of this present study came timely as it has added empirical clarification on the issue of gender achievement in relation to the use of in teaching and learning of physics concepts.

Result as evident on tables5 showed that there was no significant interaction between methods and gender on the students mean achievement scores in physics. This is because male and female students taught physics using concept mapping instructional strategy had higher mean achievement scores respectively than their counterparts taught with the conventional chalk and talk approach. By implication, the CMIS is suitable for use in teaching both male and female students in the same class. The above findings is in tandem with that of Abamba et al (2020) who compared the effects of concept mapping and mind mapping instructional strategies on students achievement and retention in radioactivity and found that there was no interaction between the methods and gender on the students retentive ability. Equally, the findings is validated by Bawaneh (2019) who examined the effect of concept mapping on achievement and retention of students in electric energy concepts and found no interaction between methods and gender on the students mean achievement scores.

CONCLUSION

Concept mapping instructional strategy was superior to the conventional chalk and talk method in enhancing students' academic achievement in physics. Equally, CMIS enhanced the mean achievement scores of male students than their female counterparts although the differences were not statistically significant. In addition, the interaction of instructional approaches and gender did not affect the achievement of the students because both male and female students in the treatment group had higher mean achievement scores more than their counterparts in the control group.

EDUCATIONAL IMPLICATIONS OF THE STUDY

The results of this study have provided empirical information on the effectiveness of concept mapping instructional strategy in enhancing academic achievement of students in physics. Utilizing the strategy will help teachers understand the properly guide both the bright and slow learners to acquire improved knowledge to handle physics tasks effectively and generally improve on their problem-solving ability. It will equally enable the physics teachers to effectively address the learning needs of the slow learners. This helps to reduce the persistent poor students' achievement in physics. The study findings has also created awareness on the need for teachers to give credence to mind CMIS in pre-service and in service training would encourage vast improvement of science teachers instructional effectiveness in the classroom. The findings from this study has also espoused the need for school administrators, professional bodies and other stakeholders in education f to disseminate the results to other groups in the society who work with children through seminars and workshops.

RECOMMENDATIONS

1. The concept mapping instructional strategy should be given serious consideration by the teachers because of its proven positive effect on student's' academic achievement and retentive ability in physics.
2. Physics teachers should improve on their instructional behaviour leveraging on the benefits of CMIS in order to enhance students' academic achievement in physics.
3. The state ministry of education in conjunction with school authorities should conduct workshops and seminars to enlighten science teachers more on the benefits of innovative teaching strategies like the CMIS in enhancing students academic achievement.

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