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Effect of Mind Mapping Instructional Strategy on Students' Retention in Physics in Senior Secondary Schools

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This study examined the effect of mind mapping instructional strategy on students' retention in physics in senior secondary schools. The research is a quasi-experimental design of the pre-test, post-test, non-equivalent and non-randomized 2 X 2 X 3 factorial design. 64 students were sampled for this study out of which 28 formed the experimental group (mind mapping instructional strategy) while 36 of the respondents constituted the control group (conventional method). The pre-test and post-test contained 20 multiple-choice questions with four options one of which was the key factor while others were distractors. Multiple-choice questions were validated by three university professors. A retention test was also conducted after 2 weeks of the whole exercise. Data collected were analysed using the mean and standard deviation to answer the research question while hypotheses were tested using Analysis of Covariance (ANCOVA) and independent t-test at 0.05 significant level. Findings revealed among others that there was a significant effect of the mind mapping instructional strategy in physics in senior secondary schools It was therefore, recommended among others that mind mapping instructional strategy should be used to teach physics concept at the senior secondary school level of education for a better performance because it improves students' performances in physics.

Keywords: physics teaching, mind mapping instructional strategy, retention, senior secondary school, physics

INTRODUCTION

Physics is one of the basic science subjects offered at the senior secondary school in Nigeria. Physics is an important subject in the secondary school curriculum because it helps the learners to apply the principles acquired through knowledge and skills to construct appropriate scientific devices from available resources (Feinstein, 2011; Kiboss, 2011). In addition, it prepares learners for scientific and technological vocations and this plays a major role in technological, socio-economic and industrial development in many countries of the world. (Mirko, Dusanka & Mirjana, 2012). Physics is a key discipline in producing qualified engineers, scientists, teachers and researchers among others.

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Despite the importance of Physics as a key subject for the technological development of a nation, the students' performance is still below expectations (Ballah & Ugwumba 2015). A number of reasons have been identified by researchers (Harry, 2011, King'aru, 2014, Ogunleye, 2009, Ogunleye, & Babajide, 2011) as factors that are contributing to the poor and fluctuating performance in Physics. Some of the reasons adduced for the poor performance in physics include students' poor attitude towards physics, lack of motivation, poorly resourced teaching and learning environment, poor mathematical ability and poor teaching method. Furthermore, poor and fluctuating academic achievements in Physics could be attributed to the teacher's strategy which was considered as a critical factor (Oladejo, Olosunde, Ojebisi, & Isola, 2011).

Erinosho, (2013) however made us realize that the teaching method employed by teachers' reflects on students' understanding of the subject and it is the important for teachers to understand and interpret the objectives of Physics for efficient, effective teaching and learning. It is therefore, necessary to use appropriate methods which involve students' active participation in teaching and learning. Teaching needs to be participatory, where all the domains of learning are engaged in learning, hence there is the need to introduce, adopt and adapt the recently used instructional strategy that are capable of sustaining not only the interest of the learners, but also helping them to understand the concepts (Adesoji & Ibraheem, 2009).

There are many instructional strategies in the teaching process such as visual metaphor, conceptual maps, conceptual diagram, semantic networks, mind maps, and so on (Eppler, 2006; Parikh, 2015). Buzan and Buzan (2010) stated that the mind map is a powerful graphic organizer of ideas which provides a universal key to unlocking the potentials of the individual brain. Mind mapping is a highly effective way of getting information in and out of your brain. Mind mapping is also a creative and logical means of note-taking and note-making that literally "maps out" your ideas. It harnesses the full range of cortical skills, words, images number, logics, rhythm, colour and spatial awareness in a single uniquely powerful manner.

The mind mapping instructional strategy is an example of a non-linear approach to learning that encourages the learner to think radically and to use only key words and images that are non-linearly linked together for new and prior knowledge (Dhindsa & Anderson, 2011). In the mind mapping, only essential words, clauses and phrases are used. This strategy is easy for the novice learner to apply and it also encourages self-expression and exploration of a concept by the student. There are no limits to associations and connections of the concept. Mind mapping allows the student to build upon existing knowledge when new information is presented that enables meaningful learning to take place (Buzan & Buzan, 1996; Davies 2011; Spencer, Anderson, & Ellis, 2013). All mind mapping have some things in common. They have a natural organizational structure that radiates from the centre and uses lines, symbols, words, colour and images according to simple, brain-friendly concepts. Mind mapping converts a long list of monotonous information into a colourful, memorable and highly organized diagram that works in line with your brain's natural way of doing things.

Statement of Problem

The aim of teaching at any level of education is to bring about the required change in the learner according to certain objectives (Tebabal & Kahssay, 2011). In order to achieve this feat it is thus necessary that teachers apply the appropriate teaching methods and strategies that best suit the students in terms of their entry behavior so that the stated specific objectives can be achieved. Studies have shown that the poor performances of most students are usually linked to the types or modes of instruction employed by teachers to impart knowledge to the students, (Odunola, 2011). Therefore, this study investigated the effects of mind mapping instructional strategy on students' retention in senior secondary school physics in Ilorin.

Purpose of the Study

The purpose of this study was to find out the effect of mind mapping instructional strategy on students' retention in senior secondary school physics in Ilorin. Specifically, the study aimed to find out the underlisted:

1. the performance of senior secondary school students in physics;
2. the effect of mind mapping instructional strategy on senior secondary school students in physics;
3. the interaction effect of mind mapping instructional strategy and gender on students' performance in physics .
4. the difference between the mean retention score of students that were taught physics using mind mapping instructional strategy and those taught without it.
5. the difference that exists in the mean retention score of male and female students taught physics using the mind mapping instructional strategy

Research Questions

The following research questions were raised and answered at $p<0.05$ level of significance:

1. What is the performance of senior secondary school students in physics?
2. Is there any effect of the mind mapping instructional strategy on senior secondary school students in physics?
3. Is there any interaction effect of the mind mapping instructional strategy and gender on students' performances in physics?
4. Is there any effect between the mean retention score of students that were taught physics using the mind mapping instructional strategy and those that were taught without it.
5. the existing difference between the mean retention score of male and female students that were taught physics using the mind mapping instructional strategy and those that were taught without it.

Research Hypotheses

The following hypotheses were formulated and tested at 0.05 levels of significance:

$\mathbf{H_{01}}$: There is no significant effect of the mind mapping instructional strategy on senior secondary school students in physics

$\mathbf{H_{02}}$: There is no significant interaction effect of the mind mapping instructional strategy and gender on students' performances in physics.

$\mathbf{H_{03}}$: There is no significant effect between the mean retention score of students who were taught physics using the mind mapping instructional strategy and those that were taught without it.

$\mathbf{H_{04}}$: There is no significant effect between the mean retention score of male and female students that were taught physics using mind mapping instructional strategy.

METHOD

The research is a quasi-experimental design of the pre-test, post-test, non-equivalent and non-randomized 2 X 2 X 3 factorial design. The population of the study was all the senior secondary

schools in Ilorin-East Local Government Area. The target population was the senior school two (SSS II) students that were offering physics in Ilorin-East Local Government Area. Two co-educational senior secondary schools were selected out of 36 senior secondary schools through the random sampling technique. Intact classes consisting of senior secondary II (SSII) students offering physics from two co-educational schools were purposively selected for this study in order to give every student the opportunity to participate in the study and not to disrupt class activities. The simple random sampling technique was used to divide the schools into experimental and control groups. This is because no specific requirement was needed to divide each school.

The experimental group (28 students) was exposed to the mind mapping instructional strategy by the research assistant that was specially trained by the researchers for the purpose. The research assistant was also equipped with an appropriate lesson plan. The research assistant took an active part in preparing the material with the help of the researchers and did all the necessary preparation in order to use the teaching method. The preparation was carried out within one week. The control group (36 students) was also taught by a school physics teacher using the conventional method of teaching with an appropriate lesson plan prepared by the researchers. The research was conducted in two secondary schools during the period allocated to physics on the class timetable. The mind mapping instructional strategy was used to teach simple harmonic motion during the lesson. All students were volunteers to participate in the study. Informed consent was obtained from all the participating students in the study. The pre-test and post-test contained 20 multiple-choice questions on Simple Harmonic Motion Retention Achievement Test (SHMRAT) with four options one of which was the key factor while the others were just distracters. Multiple-choice questions were validated by three university professors who were specialists in such area of physics. A pre-test was conducted for all the groups to determine their knowledge about the topic before the exercise started. The teaching was done for 4 weeks after which the post-test was administered to the students in all the groups. A retention test was also conducted after 2 weeks of the whole exercise. Data collected were analysed using the mean and standard deviation to answer the research question while hypotheses were tested using Analysis of Covariance (ANCOVA) and independent t-test at 0.05 significant level.

FINDINGS

Out of 64 (100%) students sampled for this study 28 (20.0%) of the respondents formed the experimental group (mind mapping instructional strategy) in which 15(23.5%) were males and 13 (20.3%) were females; 36 (56.2%) of the remaining respondents constituted the control group (conventional method) out of which 16 (25.0%) were males and 20 (31.2%) were females.

Research Question One: *What is the performance of senior secondary school students in physics?*

As revealed in Table 1, the performances of students (both the experimental and control groups) in the post-test was higher than their performances in the pre-test. In the post test the performance (18.48) of students taught physics using the mind mapping instructional strategy was higher when compared to those exposed to the conventional method with the mean score (11.73) which was fair. Also students taught physics with mind mapping instructional strategy had the mean gain score 9.58 while students that were taught using conventional method had the mean gains score 3.64.

Table 1
Descriptive statistics of students' performance in physics (before and after the treatment)

Groups		Mean	S.D.	Min	Max	Mean Gain Scores
Experimental	Pre-test	8.90	4.41	4.00	14.00	9.58
(Mind Mapping Instructional Strategy)	Post-test	18.48	6.99	12.00	20.00	
Control	Pre-test	8.09	3.79	5.00	12.00	3.64
(Conventional Method)	Post-test	11.73	4.56	7.00	16.00	

Hypotheses Testing

Ho_1: *There is no significant effect of mind mapping instructional strategy on senior secondary school students in physics*

The result in Table 2 reveals that the *F*-value of 332.457 is obtained with a p-value of 0.000 computed at 0.05 alpha level. Since p-value (0.000) is less than alpha level (0.05), the null hypothesis one is rejected and thus, there was a statistically significant effect of the mind mapping instructional strategy on senior secondary school students in physics ($F_{(1, 61)} = 332.457$, $p<0.05$).

Table 2
Analysis of covariance results of the mind mapping instructional strategy on senior secondary school students' performance

Source	Type III Sum of Squares	df	Mean Square	*F*	Sig.
Corrected Model	756.689[a]	2	378.344	168.384	.000
Intercept	1068.699	1	1068.699	475.631	.000
Pre-test	5.796	1	5.796	2.579	.113
Mind mapping	747.000	1	747.000	332.457	.000
Error	137.061	61	2.247		
Total	14234.000	64			
Corrected Total	893.750	63			
a. R Squared = .847 (Adjusted R Squared = .842)					

The Multiple Comparison Analysis is depicted in Table 3 to show where the difference lies (i.e. the effect of the treatment on students' performance in physics). As shown in Table 3, students in the experimental group that were taught using the mind mapping instructional strategy had a higher adjusted mean score of 18.48 than those in the control group that were exposed to conventional method with an adjusted mean score of 11.73. Thus, the effect of the mind mapping instructional strategy on students' performance in physics is shown by the mean score difference 6.75.

Table 3
Pairwise comparisons analysis showing the effect of the treatment on students' performance in physics

Treatment	Mean	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
Experimental (I)	18.48[a]	6.75*	.357	0.000	2.331	3.742
Control (J)	11.73 [a]	-6.75*	.357	0.000	-3.742	-2.331
Grand Mean = 15.105						

* the mean difference is significant at 0.05 level
b. Adjustment for Multiple Comparisons: Bonferroni

Ho_2: There is no significant interaction effect of the mind mapping instructional strategy and gender on students' performance in Physics.

The result in Table 4 reveals that the *F*-value of 0.453 is obtained with a p-value of 0.507 computed at 0.05 alpha level. Since p-value (0.507) is greater than alpha level (0.05), the null hypothesis two is not rejected and thus, there was no statistically significant interaction effect of the mind mapping instructional strategy and gender on students' performances in Physics ($F_{(1, 25)} = 0.453$, p>0.05).

Table 4
Analysis of covariance results showing the interaction effect of the mind mapping instructional strategy and gender on students' performance in physics

Source	Type III Sum of Squares	df	Mean Square	*F*	Sig.
Corrected Model	3.540[a]	2	1.770	.842	.443
Intercept	652.968	1	652.968	310.539	.000
Pre-test	2.858	1	2.858	1.359	.255
Gender	.951	1	.951	.453	.507
Error	52.567	25	2.103		
Total	9455.000	28			
Corrected Total	56.107	27			
a. R Squared = .063 (Adjusted R Squared = -.012)					

Ho_3: There is no significant effect between the mean retention score of students who were taught physics using the mind mapping instructional strategy and those that were taught without it.

Table 5 shows that the t-value 1.714 is obtained with a p-value of 0.022 computed at 0.05 alpha level. Since the p-value of 0.022 is less than 0.05 level of significance, the null hypothesis three is not retained. Therefore, there was a statistically significant effect in the mean retention score of students who were taught physics using the mind mapping instructional strategy and those that were taught without it ($t_{\{62\}} = 1.714$, p<0.05). The retention ability of experimental group was found greater than that of the control group. The mind mapping instructional strategy might have enhanced the retention ability of the students in physics.

Table 5
T-test statistics showing the difference in the mean retention score of students who were taught physics using the mind mapping instructional strategy and those that were taught without it

Groups	No	Mean	S. D.	df	t-value	Sig	Remark
Experimental	28	16.821	3.409				
				62	1.714	0.022	Rejected
Control	36	13.975	3.454				

*significance at $p<0.05$

H_{04}: There is no significant effect between the mean retention score of male and female students that were taught physics the using the mind mapping instructional strategy.

Table 6 shows that the t-value 1.426 is obtained with a p-value of 0.320 computed at 0.05 alpha level. Since the p-value of 0.320 is greater than 0.05 level of significance, the null hypothesis four is retained. Therefore, there is no statistically significant effect in the mean retention score of male and female students that were taught physics using the mind mapping instructional strategy ($t_{\{62\}} = 1.426$, $p>0.05$).

Table 6
T-test statistics showing the effect in the mean retention score of male and female students that were taught physics using the mind mapping instructional strategy

Gender	No	Mean	S. D.	df	t-value	Sig	Remark
Male	15	16.341	2.713				Not
				26	1.426	0.320	Rejected
Female	13	15.839	3.144				

*significance at $p<0.05$

DISCUSSION

The result obtained showed that the performance (18.48) of students taught Physics using the mind mapping instructional strategy was higher when compared to those exposed to the conventional method with the mean score (11.73) which was fair. This may be due to the treatment students were exposed to during teaching. This result is in line with Adesoji and Ibraheem (2009) whose findings showed that students exposed to the mind mapping instructional strategy performed well than students with the conventional learning strategy in Mathematics. This was further supported by Çömek, Akinoğlu, Elmaci, and Gündoğdu (2016) who asserted that one of the techniques that can be used and applied by the teacher is the mind mapping instructional strategy to improve the learning outcome of students in any subject.

Findings revealed that there is a statistically significant effect of the mind mapping instructional strategy on senior secondary school students in physics. The students taught Physics with the mind mapping instructional strategy performed better than those taught by the conventional method. This may be because the mind map arose their interest in learning, increased their creative thinking and they were able to express themselves when using the mind mapping. The obtained result is in accordance with those of Adodo (2013), Jibril, Abdullahi, Zayum and Abdullahi (2012), Oluwatosin and Bello (2014), and Onyishi (2009) in their separate studies showed that the mind-mapping strategy helped to improve students' performances in sciences. Similar result was obtained in the research carried out by Comek, Akinoğlu, Elmaci, and Gundoğdu, (2016) in Turkey which showed that with the use of the mind mapping as improves students' academic achievement in science class. Besides, researchers in Korea had shown that the use of mind mapping in science teaching improved junior high school students' creative thinking skills (Yoon & Kang, 2015). Researchers (Gagić, Skuban, Radulović, Stojanović, & Gajić, 2019) in the Republic of Serbia have also provide beyond doubt the educational

efficiency of teaching with the use of mind mapping which was found to be higher or greater than the efficiency of conventional teaching approach. Besides that the students' involvement in the experimental group was also found to be higher than the one in the control group.

Results have shown that there is no statistically significant interaction effect of the mind mapping instructional strategy and gender on students' performances in physics. This implies that male and female students exposed to the same treatment will not differ significantly in their performance scores in physics. This suggests that sex is not a barrier to performance when mind mapping is used. This is supported by the finding of Adodo (2004) that both sexes were not different in their studies when equally encouraged to use their intellectual gifts fully and that gender did not affect students learning of science and their performance. The finding also agrees with that of Alao and Abubakar (2011) that there is no significant difference between male and female students' performance in physics. Amedu (2015) revealed that gender has no influence on the students' academic performance in senior secondary schools. Udousoro (2011) found that gender does not have any significant effect on academic performance of students. However the result is at variance with Aina and Akintunde (2013) whose submission was that male students performed better than the female students in physics. Brown and Brown (2019) reported that gender influenced performance in the favour of females.

It was also reported that there was a significant difference between the mean retention score of students that were taught physics with the use of the mind mapping instructional strategy and those that were taught without it. The result may be due to the facts that the use of the mind mapping instructional strategy gives room for creativity. This implies that the treatment used improved students retention in physics. The study supported the findings of Akinwumi and Bello (2015), Ali (2013), Obunwo (2014), and Okeke (2011) that there was a significant difference in favour of the experimental group over the control group regarding the academic achievement, the scores of retention of learning, and the perception of inquiry-learning skill scores, both on cognitive and affective levels. However, the finding disagrees with the study of Oluwatosin and Bello (2015) that no significant effect of treatment was found in the retention ability of students who were taught with mastery learning approach and Mind Mapping Approach.

The findings also revealed gender as having no significant influence on the mean retention score of students that were taught physics with the use of mind mapping instructional strategy. The result of this finding disagrees however with the finding of Okeke (2012) that gender had a significant influence on the mean retention score of students taught with the use of mind mapping instructional strategy. The finding also disagrees with Anaekwe (1997) that reported a significant effect of students interaction patterns on students' achievement in favour of the female and a insignificant effect of retention in favour of the males. But the present study agrees with findings of John and Benjamin (2015) that male and female students taught algebra using problem-based learning did not significantly differ in achievement and retention scores, thereby revealing that male and female students are capable of competing and collaborating in mathematics. The result of this finding also agrees with Ezeudu (2013) that there was a significant difference in the overall achievement and retention between students exposed to concept mapping and students exposed to conventional methods. Gender was consistently insignificant to achievement and retention.

CONCLUSION

This study has provided empirical data on the effectiveness of the mind mapping instructional strategy in enhancing students' academic performances in physics. In this regard, this study concluded that the use of the mind mapping instructional strategy in the teaching of Physics at the secondary school level addressed the students' poor and fluctuating performances. The study also concluded that gender does not have any effects on the performances of students taught physics using the mind mapping instructional strategy. The study also concluded that students taught physics using the mind mapping

instructional strategy retained physics concept more than those taught without it, and that gender does not influence students' retention in physics.

SUGGESTIONS

The following are therefore suggested based on the study:

1. The mind mapping instructional strategy should be used to teach physics concept at the senior secondary school level of education for a better performance because it improves students' performances in physics.
2. The mind mapping instructional strategy should be used to teach male and female students at senior secondary schools because the treatment improves the students' performances in physics.
3. The mind mapping instructional strategy should be used to teach students with a low retention ability because the treatment enhances students' performances in physics.
4. Male and Female students with a low retention capacity should be taught with the mind mapping instructional strategy. This is because it has improved students' performances.

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