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EFFECTS OF MASTERY LEARNING STRATEGY ON PERFORMANCE IN WAVE CONCEPT AMONG SENIOR SCHOOL PHYSICS STUDENTS IN KAFANCHAN EDUCATION ZONE, KADUNA

BY

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Abstract
This study investigated the effects of Mastery Learning Strategy on performance in Wave concept among senior secondary school Physics students in Kafanchan Education Zone, Kaduna State, Nigeria. A total of 2,355 SS II Physics students constituted the target population out of which 113Physics students consisting of 68 males and 45 females were selected as sample for the study through simple random sampling technique. The study adopted pre-test, post-test quasi-experimental control group designs. Two groups were formed: one experimental and one control. The experimental group was exposed to Mastery Learning and while the control group was exposed to lecture method. Two research questions and hypotheses were raised to guide the study. The instruments used for data collection was Physics Performance Test (PPT). The instrument was validated and the Reliability coefficient of PPT was 0.80. Pearson Product Moment Correlation was used to determine the reliability coefficient of PPT. Mean and standard deviation were used to answer the research questions while the null hypotheses were tested using t-test statistical tool at P≤ 0.05 levels of significance. The findings of the study revealed that the experimental groups performed significantly better than those in control groups. There was no significant difference in the mean performance of male and female students exposed to Mastery Learning. This implies that it is gender friendly. Based on the findings of the study, it is recommended among others that, Physics teachers should adopt Mastery Learning Strategy in teaching difficult concepts like wave.

Keywords: Effects, mastery learning strategy, performance, wave concept

Introduction

Education in the world has been recognized as a veritable Instrument for nation's growth and development (Achufusi & Mgbemena, 2012). It is the bedrock on which development of any nation is based. One of the most important goals of education

is for it to be functional; that is, to serve the purpose of producing a literate society (Achufusi & Mgbemena, 2012). One of the Aims of Education is to inculcate in the child the spirit of equity, creativity through exploration of natural and local environment. Similarly, the quality of life in any society depends significantly on its standard of education (Onwuka & Moseri, 2011). The importance of science to technological and economic development of a nation is internationally recognized. All over the world, nations are classified as developed, developing or underdeveloped based majorly on their scientific and technological strength (Oluwatosin & Bello, 2015). The development of any nation depends on the quality of scientific knowledge at the disposal of such a nation. The knowledge of science is therefore a requirement in all countries and among all people globally to confront its challenges such as political, educational and economical. Developed nations of the world are rated world powers because of their scientific knowledge which is applied to technological inventions. This can only be achieved by empowering the citizens with the knowledge of science and technology and engaging them in scientific and technologically oriented careers. The National Policy on Education (FRN, 2013) stated clearly the need to train students to be able to make use of their environment to enhance the scientific and technological need of society. In view of this, the Federal Government of Nigeria has emphasized the teaching of science and technology in all institutions of educational levels in the country. One of the science subjects taught in our schools is Physics.

Physics is a fundamental science subject that is closely related to technology. It is a branch of physical science that explains the property of matter and energy and the relationship between them (Rafiq, 2017). Physics focuses on the general nature of the natural world. It has played a crucial role in the service of mankind and its principles are daily applied in homes, lives and the discoveries made by these principles have been of great importance to human existence. The reliance on technology reveals the importance of Physics to mankind. Other disciplines such as agriculture, environmental, biological sciences as well as engineering courses use the laws of Physics to better understand their studies (Oluwatosin & Bello, 2015). Physics has many applications in medicine, transportation and communication technology. The fundamental discoveries in Physics are being used by medical communities to devise new techniques for diagnosing and treatment of a variety of illnesses. Modern means of transportation such as auto-mobiles, aircraft and other forms of technological innovations and advancement are all made possible through the application of some basic laws in Physics. Also, in the entertainment industry, the principles of Physics are employed in the refinement of sound and colour mixing to create special effects in stage presentation. As one of the most active among the physical sciences, its principles formed the basis in information technology which has helped to reduce the world into a global village.

All these lead to the development of social standards in both personal and professional life. However, it is disheartening to know that, despite the importance of Physics and its applications in various fields of life, the subject has been plagued by low enrolment, poor teaching methods, limited number of professionally trained Physics teachers and poor academic performance of students in the subject (Oluwatosin & Bello, 2015). In many countries, there has been a reduction in the number of students wishing to continue with Physics (Oluwatosin & Bello, 2014). Efforts such as transformation of the curriculum, the use of students-centered approaches, training and retraining of teachers have been made from various contributions of science educators and different educational boards towards making Physics simple and less difficult for students. Attempts had been made to find ways and means of improving students' academic performance in the subject (Oluwatosin & Bello, 2015). Different strategies and approaches such as Concept Mapping, Mind Mapping, Mastery Learning, Computer Assisted instruction, Cooperative learning to mention but a few had been suggested and empirical studies such as Effects of ICT on the Academic Performances of Senior Secondary School Students (Ishtiaq, Qaiser, Naseerud & Farhan, 2017). Effects of Concept Mapping on the Academic performances of Senior Secondary School Students (Ahmad & Munawar, 2013) among others had been carried out in Physics. An important factor in the determination of students' learning outcomes in Physics is the instructional technique adopted by the teachers (Oluwatosin & Bello, 2015).

Physics teachers frequently apply the old and conservative method of teaching that is, lecture method and Physics being a science subject is an activity-oriented subject. The way it is taught is important in helping the students acquire basic scientific knowledge, better retention ability and skills to solving different problems in life. It is, therefore, important that teachers employ teaching approaches (Mills in Bello, 2012) that will give students the opportunity to be actively involved in learning of the subject. The different instructional strategies employed in teaching Physics such as Jigsaw cooperative teaching method (Bello, 2011) and concept mapping (Ahmad & Munawar, 2013) have not improved students' academic achievement in the subject to an appreciable extent. It is therefore pertinent to consider other teaching approaches such as Mastery Learning Strategy which had been used by Adodo (2013), Mitee and Obaitan (2015), to improve academic performance in other science subjects such as: Biology, Chemistry, Geography, and Agricultural Science. Mastery Learning is an instructional strategy that is based on the principle that all students can learn a set of reasonable objectives when provided with appropriate instruction and sufficient time. It is a method in which students are given unlimited opportunities to demonstrate mastery of content taught (Williams & Ochiama, 2018). That is,

students are given enough time to repeat a unit to learn better. It involves breaking down the subject matter to be learnt into units of learning each with its own objectives (Adeyemo & Babajide, 2014). It gives students the opportunity to study a material unit after unit until they master it. Mastery learning uses differentiated and individualized instruction, progress monitoring, formative assessment, feedback, corrective procedures, and instructional alignment to minimize academic achievement gaps and improve classroom practices (Bloom in Kunyanuth, Pubet & Pattarapan, 2014; Oluwatosin & Bello, 2015) and focuses on how to improve the process of mastering content rather than changing it. Following a previous lesson, the teachers administer a brief formative assessment based on a unit learning goal. The assessment as feedback informs the teacher about the students, which helps to identify what has been learnt and what needs to be learnt better. Students who have learnt the specified concepts continue their learning experiences while others who have not properly learnt the concept receive feedback paired with corrective activities different from the initial instruction and offer guidance and direction on how to remedy their learning challenges. These correctives can include varying activities, individualized instruction, and additional time to complete assignments. The challenge, therefore, becomes providing enough time and employing appropriate instructional strategies so that all students can attain the same level of learning. Obih and Ekomaru (2011) stated that, mastery learning is the mastery of a task, topic, or subject by every learner whereby the instruction is well related with the students' characteristics, and the student is given the time required to learn the task, topic or subject and at the same time given the optimum quality of instruction. This approach recognizes individual differences in students and encourages them to create their own knowledge at their own pace.

Statement of the Problem

The persistent poor performance of students in SSCE Physics for quite some time now has become a major concern to Science Educators, Parents and other stake holders in science education. The West African Examination Council (WAEC, 2022). The Chief examiner's report has reported that there has been increasing mass failure in Physics WAEC over the years. The persistent and steady increase in the failure rate among Physics students has become a major concern to science educators, Physics teachers, parents, curriculum developers and government. Studies like that of Shittu (2014) and Isiaka and Mudasiru (2014) revealed that students' performance in Physics had been consistently poor. WAEC Chief examiner's report (2022) revealed that, students perceived Physics concepts as abstract and involve calculation and Mathematical concepts. Isiaka and Mudasiru (2014) opined that teaching method adopted by Physics teachers was a major factor responsible for poor understanding and assimilation of the subject. Shehu (2016)

observed that the method of teaching affects the performance of students in both internal and external examinations negatively.

A critical look at the content of Physics as a subject in Nigeria indicates that, the traditional teacher-centered approaches are not relevant and not appropriate to promote efficient learning of the content of Physics (Afolabi & Akinbobola, 2012). To checkmate this problem, several attempts had been made by researchers such as Udo, (2010), Yero, (2011) and Akingbade and Omotade (2013) to investigate the effectiveness of teaching methods on academic performance in Physics. Therefore, there is need to adopt innovative teaching and learning strategies of 21st century. Among these strategies are Cooperative learning, Computer assisted instruction and Mastery Learning teaching strategies. Also, From the research findings of Obafemi and Onwioduokit (2013), they classified wave as one of the difficult topics in Physics curriculum of SSII that students find hard to understand which leads to poor performance. This is why the research picked waves as a concept for the present research work. Therefore, the present study used innovative approach such as Mastery Learning teaching strategy as one best method that enhances interest and performance of Physics students in Wave concept.

Research Questions

The following research questions were addressed in this study:

1. What is the difference between the mean performance scores of students taught wave concept using MLS and those taught using lecture method?
2. Is there be any difference between the performance of male and female students taught wave concept using MLS?

Research Hypotheses

The following research hypotheses were formulated and tested at $p \leq 0.05$ levels of significance.

H_{O1}: There is no significant effect between the mean performance score of students taught wave concept using MLS and those taught using lecture methods.

H_{O2}: There is no significant effect between the mean score of male and female students taught wave concept using MLS.

Methodology

The study adopted pre-test, post-test quasi-experimental control group design. Two schools were selected as the sampled schools; one served as the experimental group and the second as control group. The experimental group (EG) was exposed to experimental treatment (X_1) using MLS while the control group (CG) was exposed to lecture method (X_0). Before the treatment, Pre-test (O_1) was administered to the students to ensure comparative ability in the study subjects. The target population of the study comprised all the 2,355 (1,032 males and 1,323 females) SSII Physics students in the 36 public Senior Secondary Schools in Kafanchan Education Zone of Kaduna state. Simple random sampling technique involving "balloting" method

was used to select three Secondary Schools out of the 36 Secondary Schools in the population. This was done by taking the corresponding serial numbers of the senior secondary schools written on pieces of paper. The papers were shuffled, then two students were asked to pick out of the 36 secondary schools in an unbiased manner (randomly). The two selected schools were randomly assigned to experimental groups and control groups. A sample size of 113 was used with 56 students for the experimental group and 57 for the control group. The sample size choice was in line with the research of Creswell (2014), which allows a sample size range of 30-100. The Physics Performance Test (PPT) was used as an instrument for data collection. The instrument was duly validated, and the reliability coefficient was found to be 0.80. At the expiration of six weeks treatment schedule, post-test (O_2) was administered to the subjects of the two groups. Research questions were answered using descriptive statistics of mean and standard deviation, while the research hypotheses were tested using inferential statistics (independent t-test).

Results

Research Question One: what is the difference between the mean performance scores of Students taught wave concepts using MLS and those taught using lecture methods.

To answer question one, descriptive statistics of mean and standard deviation were used. The result is presented in Table 1.

Table 1:

Mean and Standard Deviation of Posttest Mean Performance Scores of the Experimental Group (MLS) and Control Group

Groups	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference
Experimental Group	56	17.80	3.68	0.62	9.85
Control Group	57	7.95	3.28	0.53	

Table 1 shows the summary of mean scores of students in experimental group and the control group. Table 4.1 revealed that, experimental group recorded a mean score of 17.80, while the control group recorded a mean score of 7.95. The mean score of students exposed to Mastery Learning Strategy (Experimental Group) is higher than the mean score of students exposed to lecture method (control group) with a mean difference of 9.85. This means that Mastery Learning Strategy (MLS) enhances students' performance in Physics. To find out how significant the difference is, the scores were subjected to t-test statistics.

Research Hypothesis One: There is no significant difference between the mean score of students taught wave concept using MLS and those taught using lecture method. To test null hypothesis one, post-test scores obtained from the Physics Performance Test (PPT) (Table 1) of the experimental group and the control group were subjected to t-test statistic at P≤ 0.05. Summary of the analysis is presented in Table 2.

Table 2:
t-test Analysis of Mean Performance Scores of Experimental Group and Control Group

Group	N	Mean	Std. Deviation	Df	t-Cal	p-value	Remark
Experimental Group	56	17.80	3.68	71	12.09	0.001	Significant
Control Group	57	7.95	3.28				

Significant at p≤0.05 level

Table 2 reveals that, t-value is 12.09 with the corresponding p-value of 0.001 at 71 degrees of freedom. P-value of 0.001 is less than 0.05 level of significance. This implies that there is a significant difference in the mean performance scores between the experimental group (MLS) and the control group. Therefore, the null hypothesis (HO_1) which stated that there is no significant difference between the mean performance score of Physics students exposed to Mastery Learning Strategy (MLS) and those exposed to lecture method is hereby rejected. Thus, Mastery Learning Strategy (MLS) is found to be more effective in improving students' performance in Physics than the lecture method.

Research Question Three: Is there be any difference between male and female students taught wave concept using MLS?

To answer question three, a descriptive statistic of mean and standard deviation was used. The result is presented in Table 3.

Table 3:
Mean and Standard Deviation of Posttest Scores of Male and Female Students in Experimental Group

Group	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference
Female	33	18.73	3.63	0.94	
					1.63
Male	23	17.10	3.65	0.82	

Table 3 shows the summary of mean performance scores of male and female students exposed to Mastery Learning Strategy (MLS). The mean performance score of male students was 17.10 while the mean performance score for female students was 18.73, giving a mean difference of 1.63. This shows that the mean performance scores of male and female Physics students exposed to Mastery Learning Strategy (MLS) are similar. To ascertain if the difference in the mean performance score between male and female students in the experimental group is statistically significant, the corresponding null hypothesis was subjected to t-test statistical tool.

Research Hypothesis Two: There is no significant difference between the mean performance score of male and female students exposed to Mastery Learning Strategy.

To test null hypothesis three, post-test scores obtained from the Physics Performance Test (PPT) (Table 4.5) of male and female students in experimental group was subjected to t-test statistic at P≤ 0.05. Summary of the analysis is presented in Table 4.

Table 4:
t-test Analysis of Mean Performance Scores of Male and Female Students in the Experimental Group

Group	N	Mean	Std. Deviation	Df	t-Cal	p-value	Remark
Female	33	18.73	3.63				
				33	1.31	0.59	NS
Male	23	17.10	3.65				

Not Significant at≤ p0.05

Table 4. reveals a t-value of 1.31 with the corresponding p-value of 0.59 at 33 degrees of freedom. The p-value of 0.59 is higher than 0.05 level of significance. This implies that, there is no significant difference between the mean score of male and female Physics students exposed to Mastery Learning Strategy (MLS). Therefore, the null hypothesis which states that there is no significant difference between the mean performance scores of male and female Physics students exposed to Mastery Learning Strategy (MLS) is hereby retained. Thus, Mastery Learning Strategy (MLS) is found to be more effective in improving students' performance regardless of their gender.

Discussion of the Results

The purpose of this study was to determine the effect of Mastery Learning Strategy on performance in wave concepts among senior secondary school Physics students in Kafanchan Education Zone, Kaduna State, Nigeria. To achieve this purpose, students in the experimental group were taught wave concepts using Mastery Learning Strategy, while students in the control group were exposed to lecture method. Two research questions and hypotheses guided the study. It was established through a pretest that the subjects in both groups had equivalent knowledge of wave concepts. Therefore, the observed differences in the result were due to the treatments. The results of the data analysis on the research questions and hypotheses are hereby discussed.

The result from the research question one and testing of hypothesis one as indicated in Table 1 and 2 showed that, students taught wave concepts using Mastery Learning Strategy performed significantly better than students taught using lecture method. This finding agreed with that of Achufusi and Mgbemena (2012) and Adeyemo and Babajide (2014) who suggested that the use of Mastery Learning Approach can enhance students' performance by helping them identify the strengths and weaknesses of their performance so that they could improve their achievement. The finding also agreed with that of Udo and Udofia (2014) who also discovered that students' active participation and collaboration result to significantly better performance than those taught using lecture method. The performance of the students exposed to Mastery Learning Strategy have been significant because of the opportunity the students had to interact together, share ideas, assess themselves, had their misconceptions immediately corrected by their colleagues and have better grasp of concept which intrinsically motivated their interest in achieving their own intellectual goals.

The result from the research question and testing of hypothesis two as shown in Tables 3 and 4 revealed that there was no significant difference in the performance of male and female students taught wave concepts using Mastery Learning Strategy. This finding indicated that gender has no effect on learning wave concepts with Mastery Learning Strategy because of similar mean scores of the male and female students. This result was in line with the findings of Oluwatosin and Bello

(2014) and Obafemi (2015) who observed that gender had no significant effect on Physics performance tests. However, this finding was not in line with that of Aina (2014) who found out that, male students performed better than their female counterparts in subjects requiring quantitative ability. While Jugovic, (2017) in his research reveals that girls had a higher school grade in Physics at the end of the school year compared to the boys who only had stronger intentions of choosing Physics. The use of Mastery Learning Strategy helped all students, especially the females, who came to believe that they could control their own success in learning.

Conclusion

Based on the findings of this study, it was concluded that, Mastery learning Strategy enhance students' performance regardless of their gender.

Recommendations

Based on the findings emanating from this study, the following recommendations were made:

1. The Mastery Learning Strategy (MLS) should be incorporated into the mainstream of pedagogy in the teaching of Physics at secondary school level by Nigerian Educational and Research Development Council (NERDC) because this study establishes that there is significant difference between the academic performance of students exposed to Mastery Learning Strategy (MLS) and those exposed to lecture method.
2. In-service training for Physics teachers should be organized and focus more on how to use Mastery Learning Strategy (MLS) in the teaching of Physics concepts by the government research centers like Nigerian Educational and Research Development Council (NERDC), Nigeria Institute of Physics (NIP) and relevant professional bodies like Science Teachers' Association.
3. The Mastery Learning Strategy (MLS) is gender friendly and established that gender does not play a significance role in the learning of Physics. Hence, this method is recommended as it is gendering friendly and aid learning between male and female students.

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