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Effects of the Three-Phase Constructivist Instructional Strategy on the Academic Achievement and Interest of Students in Mechanics in Physics

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***Abstract* - The study investigated the effects of the three-phase constructivist instructional strategy on the academic achievement and interest of students in Mechanics in Physics. A total of two hundred and fifteen senior secondary II Physics students were used for the study. The experimental group was made up of one hundred and fifteen (115) students while the control group was one hundred (100) students. The study adopted the quasi-experimental design of pre-test, post-test non-equivalent control group design. The study was carried out in Southern Cross River State, Nigeria. Two instruments were used for data collection viz: the Physics Achievement Test (PAT) and the Physics Interest Scale (PIS). The face validation was undertaken by three experts, two in Physics education and one in Measurement and Evaluation. The instrument was trial tested using forty students in schools not used in the study. The data from this trial test were analyzed and the PAT had a reliability of 0.83 while the PIS had a reliability of 0.79. The pretest was then administered to the experimental and control groups. The experimental group was taught with the three-phase constructivist strategy while the control groups were taught using the normal conventional teaching method. After the period of treatment, the post test was administered to both groups. The results show significant difference in the mean interest score of both the experimental and control groups in favour of the control group. Also, there was significant difference in the academic achievement in favour of the experimental group. The paper thus concluded that the three-phase constructivist strategy is a good teaching method that could evoke interest and enhance achievement among students. The paper then recommended the use of innovative teaching methods by Physics teachers in order to arouse students' interest and enhance achievement.**

Keywords: Three-phase Constructivist, Instructional Strategy, Students, Academic Achievement, and Physics.

I. INTRODUCTION

Physics is a natural science that involves the study of matter with the associated energy involve when such matter interacts with one another. Physics plays a fundamental role in all scientific and technological breakthroughs. As posited by (Ogunleye, 2011), the technological potentials of a nation could rightly be gauged by the quality of her Physics education.

Despite its importance in our technological breakthrough, Physics is widely dreaded by our secondary school students. A lot of factors had been identified as contributing to the perceived difficulty by students. Such factors include students' pre-occupation, low mathematical background, attitudes towards Physics, lack of instrumental materials, poor laboratory conditions, teachers ill-equipped and the teaching methods adopted by the teachers (Ogunleye, 2011); (Nworgu and Ugwuanyi, 2014); and (Udo and Mbia, 2016). In this study the researchers tend to focus on the teaching method.

Teaching methods, as identified above, is one of the major factors that contribute to students' low academic achievement in physics. The teaching of Physics is dominated by imparting sets of facts and laws to the students to memorize and regurgitate during examination. This does not lead to learning and technological application of Physics. This then calls for an innovative teaching method that will inculcate in the students' the spirit of inquiry which is the key to technological breakthrough. In this direction, efforts must be shifted from the teacher-centered pedagogy to the student-centered approach in classroom instructional delivery. Classroom activities must ensure hands-on and minds-on activities that can promote critical thinking and enhance creativity. It is on this ground that the three-phase constructivist instructional strategy is being advocated here.

The three-phase constructivist instructional strategy provides the learners with the opportunity of constructing knowledge. This instructional strategy is aimed at the

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discovery of new concepts by students and with the aid of planned and applied learning-teaching activities, students themselves form their own knowledge about the concept (Chukwuemeka and Chinedu, 2014).

1.1 Statement of the problem

The success or failure of any curriculum depends on what goes on in the classroom with reference to the method the teacher uses to impart knowledge to the students.

Research such as that of (Omoseno, 2013) and (Agommuoh, 2015) had indicated that performance of students in Physics in public examinations has been persistently low over the years. The problem to a large extent had been attributed to the teaching/learning process for better achievement by the students. This calls for a shift from the teacher-centered approach to the student-centered approach. The student-centered approach will ensure meaningful learning because in this approach, students are allowed to construct their own knowledge and thus take active part in the teaching/learning process. This is why this study advocates the three-phase teaching strategy.

The three-phase teaching strategy will ensure the active participation of the students in the learning process. This will then ensure hands-on and minds-on learning. This is the type of learning advocated by science educators. This learning strategy, it is hoped, will enhance the achievement of students in physics and thus aid in our technological pursuit. Also, the chief examiner's report of the West African Examinations Council 2022 showed that students find it difficult to answer questions in Mechanics correctly. This poses a lot of hinderances to the students. Hence this study is carried out using selected concepts in Mechanics to test the efficacy of the three-phase constructivist teaching strategy in Mechanics. The problem of this study put as a question is: What will be the effect of the three-phase constructivist instructional strategy on students' academic achievement in Physics?

1.2 Objectives of the study

The general objective of the study is to find out the effects of the three-phase constructivist instructional strategy on students' academic achievement in Physics.

The specific objectives are:

1) To find out the three-phase constructivist instructional strategy on students' academic achievement in Physics.
2) To find out the effect of the three-phase constructivist instructional strategy on students' interest in Mechanics in Physics.

1.3 Research questions

The following research questions were posed and answered.

Research question 1: What is the effect of the three-phase constructivist instructional strategy on students' academic achievement in Physics?

Research question 2: What is the effect of the three-phase constructivist instructional strategy on students' interest in Mechanics in Physics?

1.4 Research hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance.

HO_1: There is no significant difference in the academic achievement of students taught Mechanics with the three-phase teaching strategy and those taught using the conventional method.

HO_2: There is no significant difference in the mean interest of students taught Mechanics using the three-phase teaching method and those taught using the conventional method.

II. LITERATURE REVIEW

Physics is a branch of science that study matter and the energy changes associated with matter (Udo and Mbia 2016), defined physics as the study of matter, energy, and their interactions. Physics plays a key role in the progress of mankind. Physics generates knowledge needed for technological advancement of any nation and propels the economic engine of the whole world. At all levels of our educational pursuit, the ultimate aim of physics teaching and learning is geared towards understanding of its processes and application in everyday activities.

In Nigeria, the general objectives of Physics teaching at the secondary school level are:

- Providing basic literacy in physics for functional living in the society.
- Acquisition of basic concepts and principles of physics as a preparation for further studies.
- Acquisition of essential scientific skills and attitudes as a preparation for further studies.
- Stimulating and enhancing creativity (FME, 2009).

In order to achieve these stated objectives in the secondary school system, what is taught and how it is presented should be in such a way that will evoke critical thinking and creativity in the students and also relevant to

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their everyday experiences. The lesson presentation should be in a manner that will cause a permanent positive change in the behavior of the learners and this change should be able to evoke self-confidence and problem-solving in the students. This is what the constructivist advocate in science teaching.

In Nigeria, physics education is besotted with myriad of problems, notably among them is the method this subject is being delivered to the recipients. Among other components of the teaching process, the method of delivery of the instruction is very essential. A good instructional delivery will translate to a good learning output. But today, the delivery of instruction in our schools leaves much to be desired (Udo and Mbia 2015).

Teachers still adhere to the verbal presentation of the subject matter and learners are allowed to copy and memorize facts which will be reproduced during examinations (Okechukwu, 2015). This method does not lead to meaningful learning because physics is an activity-based subject, and its teaching must be tailored towards the total involvement of the learners in every facet of the teaching cycle. Hence the researchers advocate for constructivist teaching strategy.

Constructivism is a dynamic and interactive conception of human learning which has the view that scientific knowledge is personally constructed and reconstructed by the learners based on their experience (Nwagbo and Aham, 2015), (Nworgu, 2015) defined constructive learning as a learning strategy that lays emphasis on the active role of the learner in the teaching/learning process. Constructivism implies comprehensive learning through experience, allowing students to apply new knowledge in new contexts. Constructivism avoids the mere memorization of content imposed by the transmission model which is always void of comprehension. This implies that learners must take some responsibilities in their learning.

The constructivists believe that for effective learning of physics, the classroom learning environment must be problem-based. The constructivist model of teaching allows learners to explore, re-organize, redefine, elaborate, work in groups, interact among themselves and make meaning of tasks and thus discover new grounds for themselves. The constructivists believe that the bases of all learning are the child's own activity, as he interacts with his/her physical and social environment (Nwagbo and Aham, 2015).

The major philosophy of the constructivist is based on the following facts:

- Knowledge is constructed, not delivered, or transmitted.
- Knowledge construction results from activity; so, knowledge is embedded in activity.
- Involving students in problems makes learning relevant and meaningful.
- Students are encouraged to investigate and challenge their assumptions and suppositions (Aham, 2013).

There are many constructivists' models of teaching such as cooperative learning, problem solving, peer tutoring, among others but the researchers are advocating here the three-phase learning strategy. In the three-phase learning strategy, the students interact among themselves and also with the materials presented before them. This method stimulates more than one sense organ.

The three-phase teaching technique is a teaching method in which the teaching cycle is broken into three phases namely: Exploration, Invention(concept introduction), and discovery (concept application).

Exploration Phase: At this stage, the students are exposed to new information and may not be competent enough to tackle the activity at this stage. The new experience raises questions in the minds of the learners which the learners seek to answer. This phase allows the learners the opportunity of attempting the activity themselves. It is an exploratory stage in which the students may be unable to solve the problem but are curious to find the solution to the problem posed.

Invention (concept introduction) Phase: In this phase, the students have interacted with the physical objects and thus have gained some experience. The teacher then guides them to perform some activities. The students are engaged in discussion and interactive activities. It is at this stage that the teacher delivers the lesson in full with the learners participating adequately.

Discovery (concept application) Phase: At this stage the students are now equipped to handle some challenges. The teacher introduces some numerical problems for the students to solve. If the lesson does not require numerical problems, the students are then exposed to more challenging questions which will enable them to engage in more critical thinking and thus discover more by themselves or with the assistance of the teacher, it is observed that teaching method adopted by the teacher will determine the extent of achievement by the students.

Teaching is a series of interaction between the teacher and the learner, with the explicit goal of changing one or more of the learner's cognitive or affective status (Udo, 2011). Teaching is not a haphazard activity but rather a goal directed activity which leads to pre-determined objectives. Ogar and Adah in Udo (2011) defined teaching method as a special form or procedure of imparting knowledge. The choice of the method of teaching to suit the concept and the learners have

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been found to produce positive results, (Odetoyinbo, 2014). The large number of failure of students in science external examinations had been widely attributed to the poor method of teaching adopted by the teacher (Mkpa, 2015).

As observed by Omojuwa (2007), the current situation of science teaching and learning in our school's system in Nigeria is a concern to all. Science teaching is accomplished through the talk and chalk method which is focused on direct transmission of truth (Udo and Mbia, 2020). As posited by Udo and Mbia, more than anything else, teaching methods affect the response of pupils and determine whether they are interested, motivated, and involved in lessons in such a way as to be engaged in meaningful learning. Thus, any instructional strategy in physics/science must be taught through well-defined sets of operations that will reduce attraction to increase ideas such that students will find Physics/science class less boring, very challenging, highly motivated and demystifying.

The perception of Physics/science as being difficult or abstracted in nature is as a result of teachers using inappropriate teaching methods. Thus, a suitable teaching method enhances academic achievement. This study seeks to find out how effective the use of the three-phase teaching strategy could arouse students' interest and enhance achievement in the concept of mechanics in physics. The strategy is activity-based and involves the interaction of students with the learning materials. All things being equal, it is hoped that this teaching strategy will enhance achievement and interest on the learned concepts.

III. RESEARCH METHOD

This study on the effects of the three-phase constructivist instructional strategy on students' interest and academic achievement in physics adopted the pre-test-post-test non-equivalent control group quasi-experimental research design.

This research design could be illustrated thus:

$O_1 \quad X_1 \quad O_2 \quad \ldots E_1$

$O_3 \quad X_2 \quad O_4 \quad \ldots E_2$

Where:

O_1, and O_3 represents pre-test
O_2, and O_4 represents post-test
X_1 Represents the experimental group
X_2 Represents the control group

The study was carried out in Southern Cross River State with seven Local Government Areas. The population consisted of all the SS 2 physics students in the study area. The simple random sampling technique was used to select two schools from each local government area, making a total of fourteen schools. In each of the local government area, one school was assigned to the experimental group while one was assigned to a control group. In each of the schools selected, an intact class of the students was used. This gives a simple size of two hundred and fifteen students.

The instruments for data collection were the Physics Achievement Test (PAT) of multiple choice in nature drawn from the content of interest (Mechanics) and the Physics Interest Scale (PIS). The PAT was face validated by three experts, one in measurement and evaluation and two from physics education. After the face validation, the instrument was trial tested using forty students in schools not used for the study. The results of the trial test were analyzed to ensure the reliability of the instrument. The reliability of the instrument was 0.83 using K-R formula 20 formula.

Also, the PIS was face validated by the three experts. After the face validation, the PIS were subjected to factor analysis. Any item that falls below the 0.35 benchmark was dropped. The remaining items were subjected to reliability test using Cronbach Alpha Approach. A reliability index of 0.79 was obtained.

Before treatment, the pretest was administered to both the experimental and control groups. The experimental group was taught using the three-phase constructivist instructional strategy while the control group was taught using the conventional lecture method. At the end of the treatment, the post-test was administered to the students. The researchers moved around the schools, collected the scripts, and marked. The PIS was also administered to all the students after treatment.

The data collected were analyzed. Descriptive statistics of mean and standard deviation were used to answer the research questions while the analysis of covariance was used to test the hypotheses. All the hypotheses were tested at 0.05 level of significant.

IV. RESULTS

The result of the study is as presented below, research question by research question and hypothesis by hypothesis.

Research question 1

What is the effect of the three-phase constructivist instructional strategy on students' academic achievement in mechanics in Physics?

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To answer this research question, the mean and standard deviation of the experimental and control groups were computed.

Table 1: Mean and standard deviation on achievement of students

S/N	METHODS	NO.:	$\bar{X}$	SD
1	Three-phase Strategy	115	76.92	8.94
2	Conventional Method	100	59.09	6.84

The results in table 1 show that the experiment group had a mean score of 76.92 and standard deviation of 8.94 while the control group had a mean score of 59.09 and a standard deviation of 6.84. This shows that the experimental group had a higher achievement than the control group.

Research question 2

What is the effect of the three-phase constructivist strategy on students' interest in mechanics in physics?

Table 2: Mean interest and standard deviation scores of students in the experimental and control groups

S/N	METHODS	NO.:	$\bar{X}$	SD
1	Three-phase Strategy	115	67.20	5.91
2	Conventional Method	100	57.58	6.27

The result in table 2 show that the experimental group had a mean interest score of 67.20 and standard deviation of 5.91 while the control group had a mean score of 57.58 and standard deviation of 6.27. This indicates that the experimental group had higher interest than the control group.

Research hypothesis 1

HO_1: There are no significant differences in the mean interest of students taught mechanics with the three-phase teaching method and those taught using the conventional method.

To test this hypothesis, the analysis of covariance (ANCOVA) of the experimental and control groups are computer.

Table 3: ANCOVA results on the achievement scores of experimental and control groups

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARES	F	SIG. OF F
Covariates	3337.861	1	3337.861	61.619	0.000
Main Effects	14810.029	1	14810.029	273.401	0.000*
Methods	14810.021	1	14810.029	273.401	0.000
Explained	18147.890	2	9073.945	167.510	0.000
Residual	10833.933	212	51.0		
Total	**28981.823**	**214**	**135.43**		

*Significant at $P < 0.05$

The results in table 3 shows that there is a significant difference between students taught mechanics using the three-phase teaching strategy and those taught mechanics using the conventional teaching method. Hence, the null hypothesis which states "that there is no significant difference in the academic achievement of students taught mechanics with the three-phase teaching strategy and those taught using the conventional method" is rejected at the 0.05 level of significance. This implies that there is a significant difference in the academic achievement between the experimental group and the control group in favor of the experimental group.

HO_2: There is no significant difference in the mean interest of students taught mechanics using the three-phase teaching method and those taught using the conventional method.

Table 4: ANCOVA results of the mean interest scores of experimental and control groups

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARES	F	SIG. OF F
Covariates	104.436	1	104.436	2.948	0.088
Main Effects	4650.784	1	4650.784	131.288	0.000
Methods	4650.784	1	4650.784	131.288	0.000
Explained	4755.220	2	2377.610	67.188	0.000
Residual	7084.897	212	33.419		
Total	**11840.099**	**214**	**55.327**		

Significant at $P < 0.05$

The results in table 4 showed a significant difference in the mean interest scores between students taught mechanics using the three-phase constructivist instructional strategy and those taught using the conventional method in favor of the 3-phase approach. Thus, the null hypothesis which states that "there is no significant difference in the mean interest of students taught mechanics using the three-phase teaching method and those taught using the conventional method is rejected at 0.05 level of significance. This implies that the three-phase instructional strategy enhances students' interest in physics more than conventional teaching method.

4.1 Discussion

The main purpose of the paper was to find out the effects of the three-phase instructional strategy on students' academic achievement and interest in mechanics in physics. The results of the study showed that there is a significant difference in the mean academic achievement of students taught mechanics with the three-phase instructional strategy and those taught using the conventional method in favor of the three-phase instructional strategy. This is due to the efficacy of the three-phase constructivist strategy. The constructivist model of teaching allows the learners to explore and redefine the learning experience which makes it possible for them to discover new grounds for themselves. The result of this study is consistent with those of (Mandor, 2012), (Madu, 2014),

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(Aham 2013) that found significant difference between students taught physics using the constructivist approach and those taught using the conventional method. According to (Udo and Njan, 2017), the constructivist approach of teaching /learning encourages students' interaction and makes the learning student-centered because it encourages full participation of the students. It is a general opinion that when learners are involved in a learning task, the more they understand the learned concept. The constructivist method creates excitement in the students and induce in them critical thinking and letter understanding of the learned concepts.

The result of research hypothesis 2 also showed a significant interest between the experimental and control groups in favor of the experimental group. It indicates that the use of the constructivist strategy is a better method to be adopted to enhance the students' interest in physics. This result is consistent with that of (Akinbobola and Ikitde, 2015) that found significant difference in the interest of students between the experimental and control groups.

Interest promotes and evokes intrinsic motivation which drives and sustains students' encouragement in a particular field of study and also a major determinant of students' academic achievement. Interest is an inner force which leads to manifestation in a person's behavior. Interest determines the success or failure of a student in a particular field of study or to a very great extent, positive interest enhances achievement. Thus, it is the duty of every teacher to use innovative method of teaching in order to arouse their interest and enhances achievement.

V. CONCLUSION

Physics plays a vital role in all scientific and technological endeavors. But it is lamentable to note that our classroom situations do not convey meaningful learning on the students. We need to raise a generation whoare adequately equipped with skills and critical thinking to bring about an atmosphere needed for scientific and technological breakthrough. In order to achieve this, teachers of physics should explore instructional strategies that will make the learning environment challenging and creative.

The three-phase teaching technique is very unique because it uses different strategies at each stage of the teaching process. This makes the classroom situation challenging and less boring. This method also encourages problem-solving approach which gives room to effective learning of science in general. This method also boosts students' interest in the subject. It is interest that makes students' achievements to vary from one subject to another. A positive interest makes one to persist in an activity no matter how tedious such a task may be until success is achieved. Therefore, our classrooms situations should be geared towards enhancing students' interest in order to boost achievement, which the three-phase instructional method can offer.

5.1 Recommendations

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

1) Physics teachers should be encouraged to use the constructivist instructional strategy for lesson delivery. This will help to arouse the students' interest and enhance academic achievement.
2) Regular conferences and workshops should be organized for serving teachers on the use of constructivist and other innovative instructional strategies.
3) Innovative teaching methods should be made part of the curriculum in teacher training institutions.
4) Government and other school proprietors should equip their schools in order to make learning materials available for teachers to use and adopt innovative teaching methods.

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