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Concepts' Live Applications Strategy as an Intervention to Students' Learning Difficulties in Physics in Senior Secondary Schools in Lagos State, Nigeria

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Abstract:- Despite the importance of physics in the scientific, technological and consequently, economic development of any nation, physics in Nigerian secondary schools, has suffered serious setbacks ranging from poor teaching, poor learning, poor performance and finally to poor enrollment. Of all these, poor teaching stands out as the fundamental, since if the learners did not learn, then the teacher, has not taught. This study therefore was carried out using our indigenous local live applications of concepts to present physics in the classroom as a familiar science. Three research questions and two null hypotheses guided the study. The study employed a non-equivalent control quasi-experimental design, using a sample of 281 Senior Secondary two students consisting of two intact classes from two schools. Ninety three students (41 male and 52 Female) formed the treatment group while 188 students (101 male and 87 female) formed the control group. Pre- and post-achievement tests were used for data collection for the study and the instrument was validated by two experts in physics education. Data collected were analysed with ANCOVA using SPSS 23.0. Findings showed that there are indigenous live applications of physics concepts within the students' locality that can be deployed to teach physics. Results also revealed that students taught using indigenous live concepts' applications performed better than those taught using the conventional method [F(1,278)=220.79;p<0.05]. More so, there is statistically significant difference in performance between male and female students taught using concepts' live applications [F(1,90)=10.429; p<0.05]. It is therefore recommended that physics teachers should use concepts' local live applications in teaching classroom physics for meaningful learning and consequent better performance.

***Keywords:-** concepts, Indigenous, live applications, students' learning difficulties, physics.*

I. INTRODUCTION

Nigeria as a developing nation needs science teachers, engineers, doctors, pharmacists, scientists, technologists and the likes. Physics stands out as one of the essential science subjects that qualify one into any of these professions that ensure national growth and development. It is a science subject that deals with the fundamental constituents of the universe, the force that exerts on one another and the effects of these forces, and the most basic of the science field (Adeyemo, 2012). Knowledge of physics established the means of transport in the air, on the land and in the sea. Factory plants and equipment, home and office appliances, and the world most needed development force-the information communication technology (ICT), are all products and applications of physics. It has found usefulness in the development and use of the global positioning system (GPS), photonics and nanotechnology (Aregbede, 2016; Ben, 2010; Zohar & Bronshtein, 2008). In fact all proper functioning of lives depends greatly on science (Akintoye, 2016; Onasanya & Omosewo, 2011). Weham, Dorlin, Snell and Taylor (1984) had earlier re-iterated that physics is and will remain the fundamental science subject that has contributed significantly to the technological development of the world at large. There is no doubt that the economic development of any country hinges on the scientific and technological development driven and steered by the knowledge of physics. To keep physics knowledge and its technological applications know-how alive and ever improving from generation to generation, the irreplaceable process is teaching and learning in our schools as well as in our traditional society.

Despite the importance of physics in the scientific, technological and consequently, economic development of any nation (Onasanya and Omosewo 2011), physics in Nigerian secondary schools in the past, has suffered serious setbacks (Owolabi, 2010) ranging from poor teaching to poor learning, poor performance and finally poor enrollment. Of all these, poor teaching stands out as the fundamental, as buttressed by Mohapatra (2015) that if the learner did not learn, then the teacher has not taught. It is worrisome that, for too long, many in the science education community believed in the one-size-fit-most in terms of the methods of delivering science content (Okebukola, 2020; Okebukola, Ige, Oyeyemi, Olusesi, Okebukola & Osun 2016; Adams, 2014; Nagata, 2013; Olsen, 2012), and encouraged teachers in different nationalities and contexts to use methods that were found potent in United States and United Kingdom.

This dicey assumption resulted to, such methods as concept mapping by Joseph Novak (American), collaborative learning by James Britton (Briton), cooperative learning by Robert Slavin (American), advance organizer by Paul David Ausubel (United States of America), hierarchical learning by Robert Gagne (American) and analogies by Dedre Gentner (American), being gleefully used to teach science in non-western schools especially in Africa, in total disregard of our own science teaching–learning environment. This obviously underplayed the role of African culture, technology and context in education (Okebukola, 2010; 2020). This invariably resulted to persistent poor understanding, poor learning and the attendant poor performance. It couldn't have been otherwise, since the students do not interact with familiar learning materials (Owolabi, 2010) and do not relate the classroom physics to their context, environment and previous knowledge especially their indigenous knowledge system and indigenous live concepts' applications.

Undoubtedly, African society has rich indigenous knowledge system and indigenous live applications of physics concepts and principles that would enhance the teaching and learning of classroom physics in secondary schools, but they are not harnessed or utilised in physics class (Owolabi, 2010). Without attending formal school, Africans established so many indigenous technologies and workshops where tools and other physics concepts are applied. There is an indigenous blacksmith's workshop where energy conversions are utilized. Heat is generated in a chamber lagged with mud to reduce energy loss. Chemical energy in the woods and charcoal are converted to thermal energy and this energy is transferred by conduction through metals thereby softening or melting the metal as to shape it to the desired tools. This is the basic process in our iron and steel industries today.

Africans design tripod stand such that pot will be on top and source of heat below because they know water in the pot is poor conductor of heat, and therefore can only boil through convection after receiving the heat through conduction across the pot. They construct ladder, inclined plane, crowbar as simple machines to enable them do some work of raising loads. They construct and play percussion and stringed musical instruments knowing how to vary the tensions as to vary the frequency of the sound produced to constitute the music. It is hoped that if these familiar indigenous live applications are employed in the teaching and learning of physics concepts in the classroom, the abstractions will disappear while the phobia and difficulties of physics will be demystified and meaningful learning will be achieved, hence performance will be enhanced.

A. Research Questions

- Are there indigenous live applications of physics concepts within the students' locality that can be deployed to teach physics?
- What will be the impact of deploying the indigenous concepts' live applications within the students' environment to teach classroom physics?
- Will there be any statistically significant difference in performance between male and female students taught using indigenous live applications of physics concepts?

B. Hypotheses

- **HO_1:** There is no statistically significant difference in achievement between students taught using indigenous live applications of physics concepts and those taught using the conventional method.
- **HO_2:** There is no statistical difference between the performance of male and female students exposed to indigenous live applications of physics concepts teaching method.

II. METHODOLOGY

The study employed the non-equivalent control quasi-experimental design, using a sample of 281 SS2 students consisting of two groups of intact classes from two schools. One group made up of 93 students comprising 41 male and 51 female for the experimental group; and the other group made up of 188 students comprising 101 male and 87 female for the control.

Instruments for data collection were Focus Group Discussion Protocol and Achievement test. The Focus Group Discussion Protocol was structured to elicit the tools and local applications of physics concepts within the students' environment. The Physics Achievement Test (PAT) was developed on those concepts discussed during the FGD. The test consisted of four sections. Section A sought demographic data of the student. Section B contained 30 Physics Multiple Choice Achievement Test (PMCAT) items. Section C was Physics Essay Achievement Test (PEAT), while section D was Test of Indigenous Knowledge and Associated Scientific Principles, Concepts and Applications (TIKASPCA).

The question items were well spread according Blooms' taxonomy of educational objectives of recall, comprehension, application, analysis, synthesis and evaluation. The items were validated by five members of Okebukola Elite Research Team (ERT), and two secondary school physics teachers with at least 15 years cognate teaching experience and were ratified by an erudite physics education scholar in the Science and Technology Education Department of a university. Marking guide was developed and the total mark was 100%. The achievement test was subjected to test-retest administration at two weeks interval in a different equivalent school. A reliability coefficient of 0.76 obtained through applying Pearson product moment correlation, and the value was considered good to go.

Before treatment, 10 students made up of five from each group were engaged in Focus Group Discussion (FGD) to elicit information on indigenous live applications of concepts of simple machines such as lever systems and inclined planes; musical instruments such as African guitar and talking drum; generation/energy conversion and utilisation of heat energy in a local blacksmith workshop; generation of light and sound in the natural thunder and lightning phenomenon and their different time of arrival for noticing by the observer The researchers administered the pre-test to the students in both groups to determine their entry knowledge about the concepts and there after, the experimental group was taught using these indigenous live applications of physics concepts while the control group was taught using the conventional method. The administration of the treatment lasted for five weeks of double periods of 80 minutes per week.

For the experimental group, the researcher came to class with the indigenous live application instruments or tools which the students themselves are used to. They were manipulated by the students while the teacher explained along. In the case of blacksmith's workshop in their locality which they have visited, their previous indigenous knowledge on the operations, were harnessed for the explanation of the physics concepts involved. In the case of lightning and thunder which they have been observing, the scientific explanations of their production, various speeds and why lightning is observed before thunder were explained to their understanding. The control group was taught the same concepts or topics using the preponderant conventional method of board and marker. Illustrations were theoretically made without the relias (live or real things) in the students' locality.

The statistical tool applied for the analysis of data collected and testing of the hypotheses was Analysis of Covariance (ANCOVA) at 0.05 alpha level using IBM Statistical Package for Social Sciences (SPSS) version 23.0.

III. RESULTS

- **Answer to Research Questions**
  - **Research Question One:** Are there indigenous live applications of physics concepts within the students' locality that can be deployed to teach physics?
    Focus Group Discussion was used to analyse this research question. From the Focus Group Discussion (FGD) question items, the activities and processes in the blacksmith's workshop show energy conversions of chemical energy in wood and charcoal through burning to heat energy, conduction of heat energy in metals, softening or melting due to heat and malleability of metals. In talking drum, a wooden hollow cylinder or conical hollow frame open at both ends is covered with animal skin attached to pegs. When the skin leather or membrane is tapped, the membrane vibrates with the air column in the drum thereby producing sound regulated by pegs that adjust or alter the tension of the membrane thereby varying the frequency of the sound for entertainment.

    This is played in a skillful manner that an organized music is produced for entertainment. Similarly, African guitar is used to produce music by plucking the string, setting it into vibration, while varying the tension of the string as to vary the frequency of the sound produced thereby producing good music for entertainment. With the indigenous knowledge in the use of crowbar, the students can identify the effort, pivot, load, effort distance or effort arm and load distance or load arm, and the knowledge of these applications helps in drawing the arrangement and the calculations associated with lever systems in classroom. With indigenous knowledge, the students themselves can practically and skillfully vary the tension of the percussion membrane of talking drum, or the string of an African guitar as to vary the frequency of the sound produced as music. The students have been observing that lightning always comes before thunder as a proof that light travels faster than sound.

  - **Research Question Two:** What will be the impact of deploying the indigenous concepts' live applications within the students' environment to teach classroom physics?

Dependent Variable: Post-test Achievement

Teaching Methods	Mean	Std. Deviation	N	Mean Diff.
Concepts Live Application	67.7849	15.28344	93	
Conventional Method (control)	46.8351	9.57322	188	20.9498
Total	57.3100	12.42833	281	

Table 1: Mean and Standard Deviation of Experimental and Control Groups

Source: Field Work, 2021

Table 1 shows the mean and standard deviation of the group taught using indigenous live concepts' applications strategy as 67.79 and 15.28 respectively while of the conventional methods were 46.84 and 9.57 respectively. This portrays that Concepts Live Application strategy affects students' academic performance in physics.

- **Research Question Three:** Will there be any statistically significant difference in performance between male and female students taught using indigenous live applications of physics concepts?

Dependent Variable: Post-test Achievement

Gender	Mean	Std. Deviation	N	Mean Diff.
Male	73.9756	14.58850	41	
Female	62.9038	14.11891	52	11.0718
Total	67.7849	15.28344	93	

Table 3: Mean and Standard Deviation of Concepts' Live Applications Group by Gender

Source: Field Work, 2021

Table 2 shows the mean and standard deviation of male as 73.98 and 14.59 respectively while those of the female were 62.90 and 14.12 respectively. This implies that male students perform better than their female counterparts when concepts live application strategy is used in physics teaching.

- **Testing of Null Hypotheses**

HO₁: There is no statistically significant difference in academic achievement between students taught using indigenous live applications of physics concepts and those taught using the conventional method.

Dependent Variable: Post-test Achievement

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	35520.191[a]	2	17760.095	162.327	.000	.539
Intercept	36289.826	1	36289.826	331.689	.000	.544
Pretest Achievement	8211.814	1	8211.814	75.056	.000	.213
Teaching Method	24156.581	1	24156.581	220.791	.000	.443
Error	30415.774	278	109.409			
Total	878327.000	281				
Corrected Total	65935.964	280				

Table 3: Analysis of Covariance (ANCOVA) on the pre-test and post-test on test of concepts' live applications, for the experimental and conventional method groups.

a. R Squared = .539 (Adjusted R Squared = .535)

Table 3 shows that the students came into the treatment initially at statistically significant different levels, as Pre-test Achievement is significant, [F(1,278)=75.06; p<0.05]. It also shows that there is statistically significant difference in performance between students taught using Concepts' Live Applications and those taught using conventional method. [F(1,278)=220.79;p<0.05]. This means that students understand more and perform better when they are taught using practical live principles, phenomena, applications and examples which they can see and touch in their environment as against teaching them using the conventional method. Therefore, the hypothesis which states that there will be no statistically significant difference in achievement between students taught using indigenous live applications of physics concepts and those taught using the conventional method is therefore rejected.

HO₂: There is no statistically significant difference in performance between male and female students exposed to indigenous live applications of physics concepts teaching strategy

Dependent Variable: Post-test Achievement

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	7520.749[a]	2	3760.374	24.228	.000	.350
Intercept	11793.893	1	11793.893	75.986	.000	.458
Pre-test Achievement	4710.545	1	4710.545	30.349	.000	.252
Gender	1618.651	1	1618.651	10.429	.002	.104
Error	13968.950	90	155.211			
Total	448806.000	93				
Corrected Total	21489.699	92				

Table 4: Analysis of covariance on pre-test and post-test performance of male and female students taught using concepts' live applications

a. R Squared = .350 (Adjusted R Squared = .336)

Table 4 shows that there is statistically significant difference in performance between male and female students taught using concepts' live applications [F(1,90)=10.429; p<0.05]. This implies that male students perform better than female students when they are all taught using concepts' live applications strategy. This portrays that, male students are more observant to their environment, more skilful in manipulations of tools and link their observations to classroom work better than female students. Therefore, the hypothesis which states that there is no statistical difference in performance between male and female students exposed to indigenous live applications of physics concepts teaching method is rejected.

IV. DISCUSSION OF FINDINGS

The study revealed that, in the students' communities and local environment, there are many physics concepts' indigenous live applications harnessed and utilized by the indigenes in their social and cultural activities such as farming, fishing, hunting, fighting, cooking, raising or lifting loads, playing musical instruments. These applications and practices become inheritance from ancestors, living parents and elders, down to the students themselves. These include simple machines like knives, hoes, levers especially crowbar as first class or second class depending on the location of the pivot, inclined planes, ladder, staircase, tripod stand and heating of pots from below as an application of the fact that water is a poor conductor of heat, allowing heat to travel only by convection from down upwards and not the other way round or even sideways; the energy conversions that are utilized in a blacksmith's workshop converting chemical energy in wood/charcoal to heat energy, transferred by conduction through metals; construction and playing of music in talking drums, konga, African guitar, varying frequencies through the tensions of the string or membrane.

The finding from hypothesis one revealed that students taught using concepts' live applications performed better than those taught using conventional method. Concepts' live applications are like practical work as previous knowledge which outweighs all other theoretical teaching strategies. The students tend to understand every bit of it as the teachings involve tools/devices the students are already used to, in their society. More so, they observe it, touch it and do it, thereby involving many senses of learning. This is corroborated by the ancient Chinese proverb, 'I hear and I forget, I see and I remember, I do and I understand" (Kembe and Kembe, 2001) of which as the students hear, see the applications, touch and manipulate them, meaningful learning takes place, hence better performance. This is in agreement with the findings of Ibeh and Ndebilie (2011) who in their study, Gender and utilization of instructional materials in teaching and learning of art in secondary schools, found that there are benefits of utilizing concrete instructional materials such as developing creative abilities and hard-to access qualities such as muscular coordination, spontaneity, keener observation and originality.

More so, finding from hypothesis two showed that, there was a statistically significant difference in performance between male and female students taught using concepts' live applications. This finding reveals that when male and female students are taught using devices, applications, technologies within the locality, that illustrate classroom physics concepts, inasmuch as both male and female perform better than those taught using conventional methods, but male students perform better than female. For male to have performed better than female in this study could be as a result of the fact that culturally anything mechanical or engineering is treated masculine and females are rarely involved, concerned or given equal opportunity with male. The female children don't draw nearer as to study it or be involved. In most cases, these will require energy which females rarely have or ready to dissipate. For instance, as long as there are males, females may not use crowbar or inclined plane to raise or lift heavy loads. And so when they are used in teaching classroom physics, though it may make the lesson more understandable for both gender, but as much as the male students have been using the applications such as talking drums, African guitars, crow bar, wheelbarrow and inclined planes, no doubt they would have advantage.

This is supported by the finding of Owolabi and Akindoju (2010) in their study, 'relative effects of lecture and lecture plus computer-based drill and practice activities on students' cognitive achievement on physics', that males are more effective in the achievement scores, which was attributed to the possible fact that, drill and practice exercises and laboratory activities appeal to male students because of its supplementary role that calls for extra efforts and resilience. Further, according to Anikweze and Anikweze (2016), the NEEDS programme was intended to stimulate change in gender roles in contemporary Nigeria. But, to Obisanya (2014), the NEEDS policy was good in terms of definition and framework but actualisation of its target was crippled by endemic challenges which among others are the poor human capital consequent upon the neglect of education that produces qualified personnel for the economy, poor leadership capacity as well as policy inconsistency. This finding is also at variance with the earlier findings of Wolfenspenger (1993); Erinosho, (1997) and Esiobu, (2005) that females are more receptive when confronted with novel challenges. It is also at variance with the finding of Ezekoka (2010) that gender has no significant effect on the use of computer by the performance of boys and girls.

V. CONCLUSION

The persistent poor performance in WAEC senior school certificate examinations in physics in Nigeria over the decades, suggests that the teaching and learning of physics in Nigeria are largely. In this study, the researcher applied the teaching strategy that harnessed the indigenous concepts' live applications familiar to the students. The students became fascinated, and learned more meaningfully. As a result their performance was commendably higher than those taught as usual (conventional method). Findings showed that indigenous concepts' local live applications, if integrated into classroom physics, will solve the problem of poor performance that has characterized physics examinations.

VI. RECOMMENDATIONS

From the findings in this study, the researcher makes the following recommendations.

- Ministry of education should adapt teacher preparatory programme to incorporate indigenous knowledge and local live concepts' applications, and their integration with the classroom science.
- Physics teachers should identify and harness the relevant indigenous concepts' live applications known to the students to demystify physics.
- Physics teachers should use the local live applications of physics concepts and principles to make physics familiar and friendly
- Federal and state governments through the curriculum planners should integrate these indigenous concepts' live applications into the educational system.
- Practical physics should employ the local concepts live applications.

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- Nigerian authors of physics textbooks should use local examples and familiar illustrations to show that physics is not foreign.
- Physics teachers and authors should incorporate female students in physics demonstrations and assignments, to balance gender consideration so that physics should cease being classified as masculine subject.

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