INTERNATIONAL JOURNAL OF INCLUSIVENESS AND EDUCATIONAL RECOVERY (IJI-EDURE)
ONLINE:2971-5520, PRINT:2971-5512, UNIVERSITY OF UYO-NIGERIA

Mathematics Sensitization Package on Students' Retention in the Concept of Electricity in Secondary School Physics

Mr. Utitofon E. Michael
Department of Integrated Science
College of Education, Afaha Nsit
&
Dr. Martha Ijok Adibe Njoku
Department of Biology,
Ignatius Ajuru University of Education,
Port Harcourt

Abstract
The study was carried out to determine the effect Mathematics sensitization package on students' retention in Electricity concepts in secondary school physics. A pretest-post-test quasi experimental design was adopted for the study. Data were collected using physics retention test (PRT) from a sample of 80 students, made up to 40 males and 40 females from two public secondary schools. Independent t-test was used in analyzing the data. Findings revealed that there is a significant difference in students' retention scores taught physics using a mathematics sensitization package and those taught without it, but there is no significant difference in the retention scores of male and female students taught electricity concepts with mathematics sensitization package. Based on the findings, it was recommended among others that officials of ministry of education should organize seminars and workshops to sensitize physics teachers on the areas of mathematics that relates to physics teaching and learning.

Keywords: Mathematics Sensitization Package, Physics, Mathematics, Retention, Gender.

Introduction

Mathematics sensitization package refers to a set of mathematics concepts like variation, series, linear equations, change of subject formula that are related to concepts in Physics which, with proper elucidation is most likely to lead to improved academic achievements of students. Mathematics is seen as the language used to describe the problems in branches of science and technology. It is a subject that is related to other school subjects in areas like number and numeration, variation, graphs, fractions, logarithms, indices, algebraic processes area and volume. It is the foundation of science. Mathematics has been found to be important in the study of science subjects because of its role in development of the scientific and technological processes (Kajuru, 2010; Kankia, 2019). The mathematics required in the study of science subjects, referred to as technical mathematics, is essential in the invention and development of technologies, and acquisition of reasoning processes/skills required in understanding of

scientific concepts, principles and processes. Hence, mathematics is made a compulsory subject for students at both secondary and tertiary educational levels (Eraikhuemen, 2018)

On the other hand, Physics is the study of matter, energy and the interaction between them. Physics asks fundamental questions and tries to answer them by observing and experimenting. The physics curriculum challenges our students to solve problems, think critically, develop experimental and computational skills, and hone their written and verbal communication skills. In physics, students are exposed to several methods of teaching and learning. These include demonstration, lecture, discussion, discovery, laboratory and activity-based learning depending on the aspect one wants to teach (FME, 2013). Physics is the study of matter, energy and the interaction between them. Physics asks fundamental questions and tries to answer them by observing and experimenting. The physicists attempt to describe the interaction with the most fundamental and general law or principle possible. The aim of physics is to understand how nature work by applying scientific methodologies, to understand the most fundamental principle of nature, matter and energy and how they interact. Physics as a subject involves problem solving which requires more reasoning capabilities and abstract pattern recognition as well as manipulation of symbolic relationship. Objectives of physics as identified by FME (1988) is to able learners;

i. Develop interest in science and technology;
ii. Acquire basic knowledge and skills in science and technology;
iii. Apply scientific and technological knowledge and skills to meet contemporary societal needs;
iv. Take advantage of the numerous career opportunities provided by science and technology;
v. Become prepared for the further studies in science and technology;
vi. Avoid drug abuse and related vices; and
vii. Be safety and security conscious.

Attainments of these objectives is very crucial and require a teacher who uses learner-centered teaching approaches since learning takes place when learners are actively involve during teaching/ learning interaction. Hence, the challenge before the teacher is how to bring about meaningful teaching that will engender meaningful learning (Novak, 2002). In doing this task of teaching, the teacher should take into consideration the construction of instructional facility to help develop learners' higher intellectual skills and in turn serves as anchorage of the material to be learnt.

The physicists attempt to describe the interaction with the most fundamental and general law or principle possible. The aim of Physics is to understand how nature works by applying scientific methodologies, to understand the most fundamental principle of nature, matter and energy and how they interact.

Physics and mathematics are two subjects that are intimately and mutually connected. The study of-physics at all educational levels requires the knowledge, thought-process and skills of mathematics. Mathematical skills are required in Physics for organization and interpretation of data and for drawing meaningful conclusion about physical quantities. Mathematics as the bedrock of science is also a subject whose skills and knowledge are widely applied in the study of Physics than in any other science subject at the secondary school level and beyond. Shayer and Adey (2010) noted that growth in competence of Physics concepts demand a parallel growth in competence in mathematical concepts. One of the Physics concepts that is related with mathematics is Electricity.

The study of Electricity as embedded in the senior secondary school curriculum is important because electricity plays a key part in modern world. The working of most modern appliances such as radio, television, computer and calculator, refrigerator, air conditioner, sound system and electric fans are possible as a result of electricity (Okeke, 2001). This concept at the secondary school level is thought to be difficult, abstract and symbolic. But students' ability to manipulate symbols and use them to maneuver algebraic symbols is necessary for success in electricity concepts in Physics (Fisher, 2018). Electrical energy therefore is a form of energy resulting from the flow of electric charge. Energy is the ability to do work or apply force to move an object. In the case of electrical energy, the force is electrical attraction or repulsion between charged particles. Electrical energy may be either potential energy or kinetic energy, but it's usually encounters as potential energy, which is energy stored due to the relative positions of charged particles or electric field. The movement of charged particles through a wire or other medium is called current or electricity.

There is also static electricity which form an imbalance or separation of the positive and negative charges on an object. Static electricity is a form of electrical potential energy. If sufficient charge builds up, the electrical energy may be discharged to form a spark (or even lightning) which has electrical energy. By convention, the direction of an electric field is always shown pointing in the direction of a positive particle and would move if it was placed in the field because the most common current carrier is an electron, which moves in the opposite direction compared with a proton. Examples of electrical energy includes energy used for electric power, such as wall current used to light a bulb or power a computer, is energy that is converted from electric potential energy. This potential energy is converted into other types of energy such as heat, light and mechanical energy. For a power utility, the motion of electrons in wire produces the current and electric potential. The battery is another source of electrical energy, except the electrical charges may be ions in a solution rather than electrons in a metal.

Biological systems also use electrical energy. For example, hydrogen ions, electrons, or metallic ions may be more concentrated on side of a membrane than the other, setting up an

electrical potential that can be used to transmit nerve impulses, move muscles and transport materials. Specific examples of electrical energy include:

Alternating current (AC)

Direct current (DC)

Lightening

Batteries

Capacitors

Energy generated by electric eels. The S.I unit of potential difference or voltage is the volt (V). This is the potential difference between points on a conductor carrying one ampere (1A) of current with power of one watt (1Watt). However, several units are found in electricity include;

Electrical Energy	Unit	Symbol
Electric Power (P)	Watt	W
Capacitance (C)	Farad	F
Inductance (I)	Henry	H
Electric charge (Q)	Coulomb	C
Energy (E)	Joule	J
Energy (E)	Kilowatt-hour	Kwh
Potential difference, voltage (V) electromotive force (e)	Volt	V
Frequency (F)	Hertz	Hz
Potential difference, voltage (V) electromotive force (e)	Volt	V
Frequency (F)	Hertz	H_z

Physics as a subject involves problem solving and, thus, requires more reasoning capabilities and abstract pattern recognition as well as manipulation of symbolic relationship. (Gardner, 2013). This can only be acquired through Mathematics which provides adequate knowledge and enhance understanding of interrelationship between and among physics variables. For instance, to understand Ohm's law, students need to understand those mathematical concepts

like gradient of line, variation, while to solve problems relating to Power and Resistivity, mathematical concepts like change of subject formula, Algebraic equation, variation must be learned. This is because mathematical concepts affect their ability to manipulate symbolic relationship which according to Owolabi (2014) was a major weakness among Physics students.

On the influence of sex on academic performance in physics test, Mamudu (2019) found that exposing students to mathematical sensitization package related to concepts in science yielded a better academic performance and retention for male students than their female counterparts. Gender issues and academic achievement have become a important issue among researchers. There is an acknowledged problem of female under achievement when compared with their male counterparts apparently under equivalent conditions and this problem of female under achievement appear to be more pronounced in science and mathematics (Nworgu, 2014). The term gender refers to socially ascribed roles, responsibilities and opportunities associated with women and men, as well as the hidden power structures that govern relationship between them. Gender in essence a term used to emphasize men and women, but rather by the unequal and inequitable treatment socially accorded to them (Igwe, 2013).

Gender is a parallel and socially unequal division into masculinity and feminity. Biases and misconceptions about women and science is that, science is a male enterprise and this has remained the main focus of concern among science educators (Eze, 2010). In Nigeria, gender is still prevalent; it has persisted even within the science classroom. Some research works have shown contradictory evidences in students' achievement and retention in science.

Anaso (2008) observed that there is a number of conflicting conclusions about gender-related difference in achievement in Basic science.Tyler (2015) in a separate study found out that boys clearly performed better than girls in Mathematics test. Maccoby and Jacklin (2017) acknowledge the superiority of males over females when he noted that in all test, boys obtained higher retention scores than girls at 0.01 levels. However, despite the relationship existing between Mathematics and Physics, the subject Physics has been plagued with phenomenon of poor external results and this has become a source of worry to successive government and major stakeholders in the education sector in the country (Okpala, 2015).

In 2017, the percentage of students of students who passed their WAEC with credit in Physics and Mathematics was below 50% (Okpala, 2017). The same poor performance ratios were recorded in subsequent years of 2018 and 2019. This ugly trend has instigated the current worry among stakeholders as to the factors responsible for the poor performance of students in Physics and their inability to understand and retain Physics concept like electricity (Owolabi, 2018). Outside Nigeria a similar trend of poor retention in Mathematics has been observed (Oliver, 2008; Swatton and Taylor, 2014). The poor retention indicates that students have learning difficulties in acquiring Mathematics thought-processes and skills. The evidence from these studies seem to suggest that Mathematics classrooms may not be providing students with adequate Mathematics skills to

enhance their performance in Mathematics-based subjects in school. The study seeks to answer the question: would Physics students taught with a Mathematics sensitization package obtain higher retention scores in electricity concept than those taught without it?

Purpose of the Study

The study examines the effect of Mathematics-sensitization package on students' retention in electricity concept in Physics.

Research Hypotheses

The following null hypotheses are hereby formulated to guide the research:

(i) There is no significant difference in students retention scores taught electricity in physics using mathematics sensitization package and those taught without it

(ii) There is no significant difference between the retention scores of male and female students taught electricity concept in physics with a mathematics sensitization package.

Methodology

The area of the study was Uyo Local Government Area. It has been Akwa lbom State capital since 1987. Uyo lies between latitudes 7°2 1 3 and 7°33 1 North and longitudes 8°480 and 9°84 1 East, and has a population of over 350000 inhabitants (National Population Census, 2006). It is bounded in the North by Itu, on the South by Ibesikpo Asutan, on the West by Nsit lbom/Etinan and on the East by Uruan. The major indigenous language is Ibibio. The research design used for the study was quasi experimental. In particular the pretest and post-test design was used. This is suitable because it provides the students with the same assessment measures before and after treatment in order to determine if any changes can be connected to the treatment and also to make it possible for equivalent groups to be compared. The population of the study is made up of all the 1009 senior secondary two Physics students in all public secondary schools in Uyo Local Government Area for the 2021/2022 academic year.

Out of the thirteen (13) secondary schools in Uyo LGA, two schools were randomly selected with two streams per school. The criteria for selection were:

1. Presence of physics laboratory where meaningful teaching-learning could be carried out and
2. Quality of Teachers teaching Physics. Only professionally qualified teachers were used.

Furthermore, twenty (20) students in two intact classes were assigned to experimental (E) and control(C) groups. Experimental and Control groups were made of 40 students each comprising of 20 males and 20 females respectively. Physics retention Test (PRT) was constructed by the researchers and used for the study. This was a twenty (20) item achievement test. The questions were drawn from the Physics concept area of electricity. The questions were multiple choice test with options

A to D. The PRT was validated by a three-man team of experts in science Education Department of the University of Uyo, Uyo to ensure the instrument measures what it was supposed to measure. The reliability of the instrument was obtained using the test retest method. The instrument was administered to twenty (20) SS2 students who were not part of the sample. Pearson Product Moment Correlation (PPMC) analysis was used in establishing the reliability coefficient. The reliability index was 0.89. The PRT was scored by the researcher after administration. Each item on the PRT was scored 5 marks for a correct answer and the maximum obtainable score for each respondent was 100 marks.

Research Procedure

A pretest was administered on the two groups. This was to determine the entry behaviour of the students in terms of what they already know about what is to be taught and to determine whether or not the two groups to be compared are equivalent. In each school, the two teachers assigned to the experimental and control groups were made to teach the students. For the experimental group, the teacher taught the students the concept of electricity using mathematical sensitization package while the other teacher assigned to the control group taught the same electricity concept without the mathematics sensitization package. The teaching period lasted for two weeks. At the end of the teaching period, a post-test was administered to the students. Then two weeks later, a retention test was administered on the students. The retention test was meant to determine the amount of content materials the students were able to retain after a period of two weeks. The same PRT was used for the post test and retention test. A total of 40 SS2 students comprising of 20 males and 20 females obtained in each school formed the sample in each of the schools. This made a total of 80 students in the two schools. The reliability index of the PAT was determined two weeks from the date of post-test.

Results

t-test statistical technique was used to test the two hypotheses formulated for the study at 0.05 level of significance

Testing of Null Hypotheses

Null Hypothesis 1: There is no significant difference in retention scores of Physics students taught Mathematics sensitization package and those taught without it

Table 1: Difference in the retention scores of Physics students taught concepts of electricity using a Mathematics sensitization package and those taught without it.

Group	N	X	SD	Df	S^2	t –cal	t –crit	Decision at p<0.05
Experimental	40	48	10.5	78	110.25	2.05	1.96	*
Control	40	43	11.3		127.69			

*NB: *= significant at 0.05 level*

The result in Table 1 showed that the calculated t value of 2.05 was greater than the critical t value (1.96) for a degree of freedom of 78 at 0.05 level of significance. Hence, the hypothesis is rejected. This implies that there is a significant difference in retention of Physics students taught electricity concepts using mathematics sensitization package and those taught without it.

Null Hypothesis 2: There is no significant difference in the retention scores between male and female Physics students taught electricity concept with a mathematics sensitization package

Table 2: Effect of gender on retention of students in electricity concepts when taught using a mathematics sensitization package

Gender	N	X	SD	Df	S^2	t –cal	t –crit	Decision at p<0.05
Male	20	51	2.9	38	8.41	1.22	2.04	NS
Female	20	45	3.5		12.25			

NB: NS=Non-significant at 0.05 level.

The result showed that the calculated t-value (1.22) is less than the critical t-value (2.04). Therefore, the hypothesis is upheld. This means that there is no significant difference in the retention scores between male and female Physics students taught electricity concepts with a Mathematics sensitization package.

Discussion of the Findings

Difference in the retention scores of physics students taught with and without a mathematical sensitization package.In Table 1, the result showed that the t-cal (2.05) was greater than t critical (1.96). Thus, hypothesis was rejected. The implication here is that there is a significant difference in the retention scores of Physics students taught electricity concepts in Physics using a Mathematics sensitization package and those taught without it. The result of this work implies that students with high retention in electricity concepts in Physics did benefit from Mathematics sensitization package used earlier before teaching the concept. This is corroborated by Fisher (2018), who asserted that ability to process numerical data relates to Physics retention. This means that students" computational skills and their ability to maneuver algebraic symbols, variation, equation of straight line and series impacted positively on their retention in the concept of electricity in Physics.

Influence of Gender on student's Retention in Physics

In Table 2, the t-test analysis carried out indicated that there was no significant difference in the retention scores between male and female Physics students taught electricity concept with a mathematics sensitization package. The hypothesis stated was upheld. This implies that male (51) and female (45) students mean scores obtained in PRT were not statistically different after learning

electricity concept using mathematics sensitization package. This is contrary to the study done by Maccoby and Jacklin (2017) who acknowledged the superiority of males over females when he noted that in all tests, boys obtained higher retention than girls at 0.01 level, but study showed no difference in retention between boys and girls at 0.05 level of significance.

Conclusion

Based on the results, the study concludes that Physics students' taught electricity concepts in Physics using Mathematics sensitization package obtained higher retention scores than their counterpart taught without the package. Also, male and female students taught electricity concepts with a Mathematics sensitization package do not differ in their retention scores in electricity concepts in Physics.

Recommendations

The following recommendations are hereby made:

1. The officials of Ministry Of Education should organize seminars and workshops to sensitize Physics teachers on areas of Mathematics that are related to Physics teaching and learning.
2. Physics textbooks should be written with more problem solving approach.
3. Schools, parents and the community must seek ways of sustaining the performance of students in this all-important subject. This can be done by motivating students who excel in both internal and external examinations in the subject.

References

Eriakhuemen, I.B. (2018). Towards Improving the Teaching and Learning of Primary Mathematics in the New Millennium. *Benin Journal of Educational Studies,* 16 (2) 95 101.

Fisher, G (2018). The validity of Pre-caIculus, Multiple Choice and retention Based Testing as a Predictor of under Graduate Mathematics and Physics retention. M.Sc. Thesis Dept. of Physics, University of California Santa.

Gardner, H (2013). Frames of Mind: The Theory of Multiple Intelligences. New York: Basic Books,

Kankia, A.D. (2019). Comparing lecture Method with Discovery Method at the Level of Productivity to Learning Mathematics in Overcrowded Classes in Katsina State Secondary Schools. *Journal of Educational Research and Policy*. 3 (1), 90-95.

Kajuru, Y.K. (2010). Pedagogical strategies for Improving the Teaching and Learning of Mathematics at the colleges of Agriculture in *Nigeria Journal of Studies in Science and Mathematics Education*, 1(1)33-41

Mamudu, K. (2019).The Differential Effectiveness of Cooperative, Competitive and Individualistic Goal Structure on Students' Performance in Physics. Ph.D Thesis Dept. of Teacher Education, University of Ibadan, Ibadan

Maccoby, E. E. (2017). The Development of Sex Differences. Standford University Press.

Okpala, E. (2017).Chief Examiners Report General Certificate of Educational/School Certificate O-Level Papers. Lagos; WAEC.

Oliver, A. (Ed) (1998) Proceedings of the Twenty-second Annual Conference of the Psychology of Mathematics Association, (PME) Stellenbosch, 4(1) 3-200.

Owolabi, T. (2018). A diagnosis of Students' Difficulties in Physics. Educational Perspectives, 7(2), 15 – 20,

Senior Secondary Physics by P.N Okeke.

Shayer, M. & Adey, P. (2010). Towards a Science Teaching: Cognitive Development and Curriculum Demands. London: Heinemann Educational Books.

Swattan, P. and Tayor R. (2014).Pupils retention in Graphical Tasks and its Relationship to the Ability to handle Variables British Educational Research Journal 20(2), 227 243.

Tyler, L. E (2015).The Psychology of Human Differences. New York: Appleton Century.