

Research article

Assessing the Relative Effectiveness of Three Teaching Methods in the Measurement of Students' Performance in Physics

Owolabi Olabode Thomas & Oginni Ominiyi Israel

Department of Curriculum Studies, Faculty of Education
Ekiti State University, Ado-Ekiti

E-mail: omoniyioginni@yahoo.com

Abstract

The purpose of this study was to assess the relative effectiveness of three teaching methods on students' academic performance in secondary school Physics. The design of the study was a quasi-experimental pre-test post-test research design using intact classes. A sample of 60 students was randomly selected from three secondary schools in Ekiti South West Local Government Area. The instrument for data collection was Physics Achievement Test (PAT) developed by the researchers for the purpose of examining students' performance in Physics. Six hypotheses were postulated at 0.05 level of significance. The results indicated that students taught using Polya's heuristic method performed better than those taught using project-based instruction and lecture methods; The paper recommends among others that Physics teachers should employ appropriate pedagogical methods in order to reduce poor performances in Physics.

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Keywords: effectiveness, achievement, lecture method, heuristic method, Polya's method

Introduction

Physics education is encountering a lot of challenges in the face of varieties of scientific, technological, engineering and mathematical trauma, which seems to have become a great threat to human knowledge, and survival in the world today. Developing countries seem to even have more challenges because of their low level of education, ignorance and poverty. The unique role of physics education as a tool for enhancing science teaching need to be reinvigorated for total overhauling in education sector and modern technology. One of the major science subjects in secondary school is Physics. Its laws are typically expressed with economy and

precision in the language of mathematics. Physics dealt with behaviour of objects under the action of given force and nature which could be explained theoretically and experimentally. However, physics teaching needs diversification for better understanding depending on how best the teacher can pass the message across. It helps in creative thinking, logical and deep insight into nature.

There has been a drastic reduction in the performance of secondary school students in Nigeria in the past decades especially in Physics. This could be traceable to psychological, physiological or environmental factors, teachers' poor condition of service; lack of qualified teachers; inadequate supply of facilities and equipment; lack of motivation, lack of instructional materials; and poor method of teaching (Emaikwu & Nworgu, 2005; & Emaikwu, 2012). Physics education has been awfully reported and acknowledged by all as a subject that is predominantly taught in laboratory, without considering remote and underdeveloped settlement where it is necessary for government to establish at least a secondary school with or without laboratory through which devising other teaching technique in such scenario is inevitable. Owolabi and Oginni (2012) remarked that teachers achieve more if given the opportunity to improvise materials on what to be taught in the classroom.

Abysmal performance of Physics students at post primary level is incontrovertibly attributable to pedagogical approaches adopted by teachers in schools. It has been reported that learning and understanding of school subjects have been frustrated by the clumsy methods and instructional materials used (Etukudo, 2006). Ogunniyi (2009) adduced poor performance in public examination to teaching techniques by teachers. The effect of poor performance in physics resulted into low achievement and low retention level in students' outcome both in internal and external examinations.

Mtsem (2011) reported that teaching method affects the responses of students and determines whether they are interested, motivated and involved in teaching learning process. What constitutes good teaching and learning of school subjects is the use of appropriate methods of teaching. Ogunniyi (2009) asserted that one of the most persistent and compelling problems besetting achievement is poor quality of teaching. Corroborating this assertion, Harrison (2010) reported that many school subjects especially Physics is not being learnt as it ought to be in Nigeria secondary school because of inappropriate teaching methods. Oginni and Owolabi (2012) reported several instructional strategies to be employed by various teachers in the teaching of Science and Mathematics, thereby encouraged the use of programmed instruction as a panacea to students' dwindling interest in Mathematic and sciences. The study of physics as a subject should be regarded as a necessary part of human endeavours. Unfortunately today, it is observed that many students have developed negative attitude towards the subject. It has become almost a general belief among students that physics is an abstract subject and hence too difficult to learn. Owolabi (2009) discovered that the rate of failure in the subject at the seniors secondary school external examination is alarming and reduction in the number of students offering the subject over the years call for concern.

Due to the inappropriate equipment, limited time allocated for the topic and poor laboratory conditions, teachers teach physics anyhow and anywhere. This development is detrimental to the basic constructivist philosophy of

laboratory method which accepts that knowledge can be gained through personal experience and observation (Owolabi and Oginni, 2012). It is pertinent to consider appropriate alternatives means of imparting knowledge so as to defend quality science teaching and learning from going into extinction when the need arises. Among these alternatives is the use of educational technologies, more specifically use of computer in supporting the laboratory methods for logical reasoning (Kiyici and Yumusak, 2005). There are numbers of teaching methods available for teachers to use which include lecture method, discussion method, demonstration method, discovery or inquiry (activity) method, laboratory method, Polya heuristic problem solving method, project-based instruction and individualized instructional method.

The conceptual nature of physics, however, lends itself to several methods. Project-based instructions places the emphasis of student learning on real-life practice, while lecture-based instruction relies on introducing new and complicated information to students in a familiar way. In both situations, the instructor must make extensive preparations to ensure the maximum level of student learning and that students will use different skills to interact with the information. Lecture-Based instruction is effective for teaching the history of physics and other fact-based information which help introducing students to “fill-in-the-blank time-line” of important concept in physics. The instructor need to prepare extensive notes on each concept that includes a graphic organizer and visual note sheet for the student. Providing the student with information both orally and visually is a vital part of instruction needed especially where there is no standard laboratory. Graphic organizers allow students to follow along with the lecture and build learners’ understanding of each concept with the instructor. It also allows the instructor to informally assess student knowledge as the lesson progresses. Scholars refer to lecture method to be telling method which is different from teaching, even though, the method affords the class, opportunities to obtain useful and essential facts, information and knowledge at the minimum expense of time. Ogwuozor (2006) asserted that the most prominently used approach in the teaching of sciences in secondary schools is the often criticized lecture method as against the activity method.

There is no single method which can be regarded as best for every teaching situation. Ada (2005) reported that there are numbers of criteria available that may guide the teacher in the choice of any given method of teaching which include: the content to be taught, objectives to be achieved, time available, number of students, teachers’ preferences and individual differences, the type of lesson, facilities available, needs and interest of the class, among others. Adebola (2009) observed that students taught physics using heuristic method scored higher in achievement test followed by demonstration method while field and lecture methods scored the least. This indicated that there is a significant relationship in the instructional strategies employed by teachers for students’ achievements. Problem solving method in the teaching of science students’ influence their academic performance and students taught physics via problem solving method have a mean score higher than their counterparts who were taught the same concept with lecture approach.

Good teaching is the result of exposing students to certain experience through adequate guidance and providing appropriate learning activities so that they acquire the best form of learning. In spite of efforts made by teacher and learners, we often discover that learning still falls short of desire expectations. This deplorable situation

urgently requires physics educators and curriculum planners to pay attention so as to arrest the problem quickly before too much efforts and time are wasted. (Owolabi, 2008). The problem of this study therefore is to ascertain which of the teaching methods enhances better performance of secondary schools students in physics. The study comprises three methods (lecture based instruction, project based instruction and polya heuristic method of teaching) with a view to determine the most effective method that would complement the teaching of physics.

Research Hypotheses

The following hypotheses were formulated to guide the study and were tested at 0.05 level of significance

1. There is no significant difference in the pre-test scores of students taught Physics using lecture method, Polya heuristic method and project-based solving method.
2. There is no significant difference in the post-test scores of students taught Physics using lecture method and Polya heuristic method
3. There is no significant difference in the post-test scores of students taught Physics using lecture method and project-based method.
4. There is no significant difference in the post-test scores of students taught Physics using Polya heuristic method and project-based method.
5. There is no significant difference in the post-test scores of students taught Physics using lecture method, Polya heuristic method and project-based solving method.
- 6.

Methodology

The population of this study consisted of all Senior Secondary School (S.S.S 2) students across Ekiti South West Local Government Area of Ekiti State..The sample consisted of sixty (60) SS2 students selected from three secondary schools using simple sampling technique. The research design of the study was a pre-test, post-test quasi-experimental design. The instrument Physics Achievement Test (PAT) used for the study was designed by the researchers. It consisted of sections, A and B. Section A consisted of students Bio-data while Section B consisted of 50- item selected from mechanics aspect of Physics. Each item of the instrument has five options. Face and content validity of the instrument was censured by the curriculum experts and physics educators. The inter-rating of the validity of the instrument yielded 0.71 coefficients. The reliability coefficient of the instrument for the study was determined by using Cronbach alpha coefficient. The reliability coefficient for the cognitive Physics achievement test (CPAT) was found to be 0.86.

Data Analysis

The null hypotheses formulated were tested using t-test, Analysis of Variance (ANOVA), and Turkey Multiple comparison at alpha level of 0.05.

Hypothesis 1; There is no significant difference in the pre-test scores of students taught Physics using lecture method, project-based instruction and Polya heuristic problem solving method.

Table 1: ANOVA summary of pre-test scores on three methods of teaching physics

Source of variation	SS	df	MSS	F _{cal}	F _{tab}	Result
Between	3.81	2	1.905			
Within	206.7	57	3.626	1.0507	3.17	Sig
Total	210.51	59				

Table 1 showed that $F_{cal}(1.0507)$ is lesser than $F_{tab}(3.17)$ at 0.05 level of significance, however, the null hypothesis is not rejected. Therefore, there is no significant difference in students' performance in physics prior treatment. The homogeneity in the performance of students in each group propelled the study further.

Hypothesis 2; There is no significant difference in the post-test scores of students taught Physics using lecture method and project-based instruction.

Table 2: t-test summary of post-test scores on lecture and project-based instruction method of teaching physics

Source of variation	\bar{x}	SD	df	t _{cal}	t _{tab}	Result
Lecture	14,45	2.2907				
			38	1.8097	2.021	NS
project	19.25	1.3370				

Table 2 shows that $t_{cal}(1.8097)$ is lesser than $t_{tab}(2.021)$ at 0.05 level of significance, however, the null hypothesis is not rejected. Therefore, there is no significant difference between students' performance in physics when exposed to lecture and project-based instruction

Hypothesis 3; There is no significant difference in the post-test scores of students taught Physics using lecture method and Polya heuristic problem solving method.

Table 3: t-test summary of post-test scores on lecture and polya method of teaching physics

Source of variation	\bar{x}	SD	df	t _{cal}	t _{tab}	Result
Lecture	14,45	2.2907				
			38	3.2186	2.021	S
Polya	24.05	1.9098				

Table 3 shows that $t_{cal}(3.2186)$ is greater than $t_{tab}(2.021)$ at 0.05 level of significance, however, the null hypothesis is rejected. Therefore, there is significant difference between students' performance in physics when exposed to lecture and polya method of teaching in favour of polya heuristic teaching method whose mean score is higher than that of lecture method.

Hypothesis 4; There is no significant difference in the post-test scores of students taught Physics using project based instruction and Polya problem solving method.

Table 4: t-test summary of post-test scores on project based instruction and polya method of teaching physics

Source of variation	\bar{x}	SD	df	t_{cal}	t_{tab}	Result
project	19.25	1.3370				
			38	2.0589	2.021	S
Polya	24.05	1.9098				

Table 4 shows that $t_{cal}(2.0589)$ is greater than $t_{tab}(2.021)$ at 0.05 level of significance, however, the null hypothesis is rejected. Therefore, there is significant difference between students' performance in physics when exposed to project based instruction and polya method of teaching in favour of polya heuristic teaching method whose mean score is higher than that of project based instruction

Hypothesis 5; There is no significant difference in the post-test scores of students taught Physics using lecture method, heuristic method and Polya problem solving method.

Table 5: ANOVA summary of post-test scores on three methods of teaching physics

Source of variation	SS	df	MSS	F_{cal}	F_{tab}	Result
Between	921.6	2	460.8			
Within	213.65	57	3.748	122.95	3.17	Sig
Total	1135,5	59				

Table 5 shows that $F_{cal}(122.95)$ is greater than $F_{tab}(3.17)$ at 0.05 level of significance, however, the null hypothesis is rejected. Therefore, there is significant difference in students' performance in physics when exposed to lecture, project-based instruction and polya heuristic method of teaching

Table 6: Turkey multiple comparison summary of post-test scores on three methods of teaching physics

Construct	\bar{Y}	\sqrt{Y}	α	S_i	S_T	Result
$X_1 - X_2$	-4.8	4.8	0.6122	7.841		Sig
$X_1 - X_3$	9.6	9.6	0.6122	15.681	2.517	Sig
$X_2 - X_3$	4.8	4.8	0.6122	7.841		Sig

In order to ascertain how significant is the three methods of teaching on performance in Physics, lecture (X_1) project-based instruction (X_2) and polya heuristic (X_3) shows the degree of variability. Although, turkey

statistical analysis revealed that there are variation in the performance of students at all levels, yet polya heuristic method gave the highest significant.

DISCUSSION OF FINDINGS

The result of data analysis in hypothesis 1 revealed that F- calculated value of 1.05 is less than F-table 3.17. Therefore, we have statistical reason not to reject the null hypothesis; hence there is no significant difference in the pre-test score of students taught Physics using the three methods. This is an indication that there was homogeneity in the academic achievement of students in the groups prior treatment. Table 2 showed that the t-calculated value of 1.8091 is less than t- table of 2.021. Therefore, we do not reject the null hypothesis and conclude that there is no significant difference between the post-test score of students taught physics using project-based instruction and lecture method. This implies that the two methods possess equal strength in the teaching and learning of physics.

The results of table 3 contradicted the findings of table 2 where Polya's method revealed a significant difference while compared with the lecture method in favour of polya with t- calculated of 3.2183 greater than t-table of 2.021 The lecture method according to this study was the least performing method with a mean achievement score of 14.45. It is therefore necessary to note that, for effective teaching to occur in physics, the teacher should get the learners involved in activities that will enable them to develop the needed process skills and attitudes relevant to their science and technology pursuit.

The result of hypothesis 4 indicated that there was a significant difference in the achievement scores of students taught physics using project-based instruction and Polya's heuristic methods. A high achievement was recorded when Polya's method was used in physics teaching. The result of this finding supported earlier report by Herwit (2007) who asserted that children learn best by doing not just by sitting and listening. The result of this study supports other researchers' assertion that Polya's problem solving method is superior in developing students' abilities in applying concepts, developing positive attitudes, fostering motivation, and encouraging appropriate group social skills compared to other teaching methods. The findings of the study are in conformity with Welbery (2009) who also affirm that problem solving featuring active students' participation in the learning process and produces superior results than lecture method. This gave credence to Olofin (2006) submission that students taught mathematics using Polya's problem solving method scored higher in achievement test than other methods

Table 5 showed that F- calculated values 122.95 were greater than the F- table of 3.17 in the ANOVA summary of the post test on lecture, project-based instruction and Polya's heuristic methods. Hence, we have statistical reason to reject the null hypothesis and conclude that there is significant difference in academic achievement in physics considering the three methods. Turkey multiple comparison exposed that the two groups that have relatively high scores are project-based instruction and Polya's heuristic methods. This invariably shows that, the combination of two methods improve effectiveness in the achievement recorded than just using lecture method alone.

CONCLUSION

The result of this study has provided an empirical basis that Polya's heuristic problem solving method is an alternative teaching strategy capable of improving the present dismal and poor achievement of students in physics especially when standard laboratory is scarce. It is therefore evident that the use of Polya's heuristic method enhanced student's achievement in the real sense than project-based instruction method; while lecture method showed the least achievement in physics. Based on the results of the study, it can be concluded that there was a significant difference in the mean achievement scores of students taught physics using the three pedagogical methods. Hence students' performances in physics vary significantly when lecture, project-based instruction and Polya's heuristic methods are used in teaching physics in favour of Polya's heuristics method.

RECOMMENDATIONS

In the light of these findings, the following recommendations are made:

- ✓ For effective teaching of physics, attention should be given to qualified teachers to handle the teaching of sciences
- ✓ Teachers should deliver their lessons to students using Polya's heuristic problem solving this will invariably internalise a process-skill in the students thus inducing their critical thinking and conceptual understanding.
- ✓ Teacher should get the learners involved in activities that will enable them to develop the needed process-skills.
- ✓ Physics teachers should interact and share their experiences with one another through seminars and workshops to discover better strategies of teaching with a view to improve students' achievement in the subject.
- ✓ Teachers should be encouraged to develop creative knowledge in improvising some models and teaching aids for use during lessons.
- ✓ Ministries of education, curriculum planners and developers should outline appropriate methods for teachers to teach various topics highlighted in the physics curriculum.
- ✓ physics teachers should employ appropriate pedagogical methods in order to reduce poor performances in Mathematics

REFERENCES

- [1] Ada, N.A. (2005). The Nigerian teachers as a key to better world: Issues and challenges. Akure: Peace Global press.
- [2] Agbo, N. (2012, June 4). Joint Admission Matriculation Board reduces University admission to 180 marks. The Nation, p. 10. (<http://www.thenationonlineng.net>)
- [3] Aiken, L.R. (2007). Intellectual variables of mathematics achievement. Research Journal of School Psychology, 9, 201-206.

- [4] Akaanyi, A. (2004). Teaching methods employed by secondary school mathematics teachers. An unpublished P.G.D.E project. Benue State University, Makurdi.
- [5] Akem, I. A (2007). Practices and teaching methods. An unpublished lecture notes of the College of Education, Katsina–Ala Benue state.
- [6] Becker, J. R. (2005). Differential treatment of females and males in mathematics classes. Journal of Research in Mathematics Education, 12 (3), 40-53.
- [7] Emaikwu, S. O. & Nworgu, B. G. (2005). Evaluation of the context and presage variables in the implementation of further mathematics curriculum in Abia State. Journal of Educational Innovators, 1 (1), 7-16
- [8] Emaikwu, S. O. (2012). Assessing the effect of prompt feedback as a motivational strategy on students' achievement in secondary school mathematics. Journal of Educational Research, 3(4), 371-379.
- [9] Finn, J. D. (2008). Sex differences in educational attainment. Harvard Education Review, 49, 477-503.
- [10] Fryer, R.G. & Levitt, S.D. (2009). An empirical analysis of the gender gap in mathematics. American Economic Journal: American Economic Association, 2 (2), 210-240. Retrieved from www.nber.org/papers/w15238.
- [11] Glenn, E. & Ashley, S. (2009). The Gender gap in secondary school mathematics at high achievement levels: Evidence from the American mathematics competitions. Journal of Economic perspective: American Economic Association, 24 (2), 109- 128. Retrieved from www.nber.org/papers/w15238.
- [12] Guiso, L., Monte, F., Sapienza, P. & Zingales, L. (2008). Culture, gender and mathematics. Science, 320, 1164 -1169.
- [13] Harrison, C. (2008). Educations for tomorrow's vocational teachers: Overview. Digest No. 67.
- [14] Herwit, J. S. (2002). Teaching methods for today's school collaboration and inclusion. London: Allyn and Bacon.
- [15] Hyde, J. S. & Mertz, J. E. (2009). Gender, culture, and mathematics performance. Proceedings of the National Academy of Science, 106(22), 8801-8807.
- [16] Kelly, A. (2007). Why girls don't do Science. Ibadan: University Press.
- [17] Kolawole E.B & Popoola A.A. (2009). Effect of using Problem solving method in the teaching of senior secondary school mathematics on students' academic performance. International Journal of Mathematics Education, 16 (2), 212-231.

[18] Mtsem, A. A. (2011). Effects of diagnostic and contextual instructional strategy on students' interest and achievement in Secondary school Algebra. A PhD thesis of the Faculty of Education, Abia State University Uturu

[19] Odili, G.O. (2006). Mathematics in Nigerian Secondary School: A Teacher Perspective. PortHarcourt: Rex Charles and Patrick Ltd.

[20] Oginni O.I and Owolabi O.T (2012) Integration of programmed instruction into mathematics and science teaching; a panacea in students dwindling interest in mathematics and science in Nigeria schools European journal of education research (1) 3, 199-209 Available online <http://www.wakademicplus.com/eujer/index.html>

[21] Ogguniyi, M. B (2009), Science, technology and mathematics. International Journal of Science Education, 18 (3), 267- 284.

[22] Olofin, S. O, (2006). How mathematics teachers use lecture and problem solving methods in the classroom. An unpublished NCE project of College of Education, IkereEkiti.

[23] Owolabi O.T and Oginni O.I (2012) Improvisation of science equipment in Nigeria schools, Universal journal of education and general studies 1 (3) 044-048 Available online <http://www.universalresearchjournals.org/ujegs>

[24] Popoola, A. E. (2012). Effect of motivation on students' performance in mathematics. An undergraduate project submitted in the Faculty of Education, University of AdoEkiti

[25] Welbery, H. J. (2009). Improving school science in advanced and developing countries. Review of Educational Research, 61 (1), 25-69.

[26] Krajcik, J., Mamlok, R., & Hug, B. (2001). Modern content and the enterprise of science: Science education in the twentieth century. In L. Corno (Ed.), Education across a century: The centennial volume (pp. 205–238). Chicago: University of Chicago Press. 100th Yearbook of the National Society for the Study of Education.