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Effects of Problem-Solving Strategy on Students Motivation and Academic Achievement in Secondary Schools Physics in Jos, Plateau State, Nigeria

Isa Shehu Usman (Ph.D)
Physics Education
Faculty of Education, University ofJos
E-mail: isausman2015@gmail.com
&
Opara Sabinus Ikechukwu
St. Theresa Girl's College, Jos
No. 1 Danja Street, Jos-Plateau State
Sabike4u@gmail.com

Abstract
This study investigated the effects of problem-solving strategy on Physics students' motivation and achievement in secondary schools in Jos, Plateau State, Nigeria. The research design used in this study was quasi-experimental. Specially, the pre-test post-test control group design. The population for this study was 1000 SSII physics students and two coeducational secondary schools (public and private) were sample. Two instruments namely Physics Achievement Test (PAT) which consisted of 25 multiple choice questions and Physics Motivation Rating Scale (PMRS consisted of 20 items were used for data collections. The PAT and PMRS were validated by three experts in physics, physics education, test measurement and evaluation all from University of Jos, Nigeria. Four research questions were posed and answered and four null hypotheses were formulated and tested at 0.05 level of significant using mean, standard deviation, variance and t-test statistics respectively. The statistical computation was done using Version 22 SPSS. The reliability coefficient of the PAT was found to be 0.81 and that of the PMRS stood at 0.71. The study revealed that there is significant difference in the mean academic achievement of SS2 physics students exposed to problem-solving strategy and those exposed to lecture method. The study also revealed that no significant difference exit in the mean academic achievement between male and female students exposed to problem-solving strategy. This implies that problem-solving strategy is gender friendly. Finally, the study revealed significant relationship between problem-solving strategy and students' motivation towards physics. Based on the findings, it was recommended that physics teachers should constantly used appropriate methods of teaching physics that would encourage students to learn physics effectively in secondary schools.

Key words: Physics, problem-solving, strategy, motivation, ACADEMIC, Achievement

Introduction

Physics is a branch of science that deals with the study of matter and energy and their interaction. It is sometimes referred to as the science of measurement and its knowledge has contributed greatly to the production of instruments and devices of tremendous benefits to the human race. Physics provides the basic knowledge and understanding of principles, whose applications contribute immensely to the quality of life in the society.

There exists a strong link between progress in physics and technological advancement of the society. It provides the theory behind technology and it is the foundation of any theoretical and applied knowledge. Physics is considered essential to give evidence of the students' success in Medicine, Engineering and other sciences like Chemistry, Anatomy and Cosmology. The application of Physics through technology is crucial for providing the instructional resources needed by a nation. Physics, being the most basic of science, underpins the comprehension of other sciences and science-related fields. For instance, a thorough understanding of quantum mechanics is necessary for Chemists and Material scientists to understand the structure of every matter in the universe.

The objectives of teaching Physics at secondary school level include: Learning of fundamental facts and principles of science and development of the abilities and skills needed to engage in the processes of science, among others (FME, 2005). It is expected that it is from among the students at secondary level that future Physicists, engineers, doctors and technologist, among others will emerge. For physics to retain its position as bedrock of science and technology and its objectives achieved, it is important to ensure that the way it is being taught interests Nigerian students at the secondary level.

The extent to which learners learn depends on their level of motivation which can be stimulated by the nature of the learning environment and the teaching strategy adopted by the teacher. The teacher's role is to influence the motivation of learners to learn by using teaching strategies that can impact learners' attitudes towards learning, build on their self-concepts and raise their educational aspirations. The work of the physics teacher is made easier when his students are motivated. Motivated physics students are eager to learn, willing to undertake learning activities and attend lessons regularly and punctually. This implies that motivation is as an important determinant predicting students' achievement in learning. Hence, students need to be constantly motivated to ensure effective teaching and learning of physics.

There is need for Physics teachers to adopt proper strategy for teaching concepts of Physics involving mostly computation and such strategy is the problem-solving. Metallidou (2009) define problem solving as a "goal-directed behavior that requires an appropriate mental representation of the problem and the subsequent application of certain methods or strategies in order to move from an initial, current state to a desired goal state. Problem-solving strategy is a method that can potentially produce effective and meaningful teaching and learning as it is a strategy that is applied experientially and is student-center. A research performed by Kadir (2005) found that the implementation of problem-solving strategies in teaching and learning can improve the results of learning, especially in increasing knowledge, understanding, application, and also achievement. A high level of problem-solving skills is required to successfully solve problems and in order to master these skills; students must use the strategies often.

According to Serap and Gamze (2010), problem-solving strategies are significantly linked to the elements involved in problem-solving procedures. So is a basic skill needed by all students, but at the same time, can also be a complex mental activity. The implementation

of problem-solving in the teaching and learning environment could improve the quality of learning. Through this strategy, students have to find information and solve problems through their own efforts; this process compels them to be independent and to think critically and creatively.

The exposure to problem-solving strategies that students receive could help them improve their achievement, increase their interest in a subject, and change student attitudes towards learning (Gök & Silay 2010). According to Taconis, Fergusan-Hesler and Broekkamp (2001) problem-solving strategy can be taught and learned. The goal of the application of problem-solving strategies in teaching and learning is to give students a chance to use the skills they have learned in tackling relevant problems. Previous research has found that the application of this method in teaching and learning produces positive effects on student achievement and student skills in problem-solving, (Adesoji, 2008).

Statement of the Problem

Atadoga (2011) showed that teachers' instructional strategies contribute majorly to student academic achievement in their course of study. Atadoga and Onaolapo (2008) opined that there is no best single method in the teaching of school subjects. Atadoga and Onaolapo (2008) further stressed that the choice of any instructional strategy is determined by the concept to be taught and teachers' ability to handle the teaching strategy among others. If teachers use wrong strategies to teach physics to the students, the result may likely be poor.

Many students in their quest for easy subject combination in school and choosing of a career path in senior secondary school tend to avoid any calculation subject-Physics inclusive. Hence, there is need to motivate students towards become proficient problem solvers in Physics through use of the appropriate methods by teacher for students achievement in the subject. Owolabi (2008) discovered that mistakes made by students while performing arithmetical operations involved in solving physics problems contributed greatly to their poor achievement in Physics. Owolabi (2008) found that students who perform poorly in physics have inadequate **b**ackground in mathematics. Despite the importance of Physics, there are a number of observable problems plaguing the teaching and learning of the subject, especially at the secondary school level. One of which is poor method of instruction. This is supported by the assertion of Agommuoh and Nzewi (2003) that deterioration in students' achievement in Physics is due to ineffective method of teaching Physics. This perhaps may be the reasons for students' poor academic performance in the subject both at the secondary and tertiary school levels. Based on this deplorable trend of poor performance Physics educators have designed some strategies over the years to curb the problem of underachievement in the subject. One of such strategies is problem-solving strategy.

Statistics obtained from the Research Library of the West African Examinations Council Headquarters Office, Lagos shows that between 1999 and 2009 in Nigeria, students' performance in Physics at the Senior School Certificate level is poor as the percentage pass at credit level and above consistently falls below 50% except in the years 2004 and 2006 when it was 51.02% and 58.05% respectively. In one of the years with these fairly high percentage

passes. That is in 2006, the highest proportion of candidates who sat for the examination had their results either cancelled or withheld. This incidence might be due to students' involvement in one form of examination malpractice or the other out of desperation to pass. This puts to question the reality and reliability of the high level of performance and by extension the quality and effectiveness of the teaching-learning process in schools.

Poor achievement in physics could be attributed to many factors ranging from the attitude of students towards the subject, methods of teaching the subject which may be linked to the use of instructional strategies which have not totally incorporated learners' previous knowledge and how they reasoned. This is more so as instructional strategies adopted by teachers have not solved the problem probably because those strategies have not actually focused on learners as constructors of their own theories and knowledge. Learners need to be made to construct their own knowledge and ideas in learning because they are the architects of their own learning and constructors of their own ideas and knowledge.

A popular method of teaching problem-solving involves the use of "stage models". Stage models are simplified lists of stage and steps used in general problem-solving. These skills can be considered as the analytical parts (heuristics) of the problem solving process which requires defining, investigating, reviewing and processing of the information regarding the problem. Literatures have shown that there is paucity of research in the area of physics problem solving in Jos. Even the ones carried out did not investigate the variables of achievement and motivation or students' achievement. In view of this, this study therefore determines the effects of problem-solving strategy on students' motivation and achievement in Jos, Plateau State, Nigeria.

Purpose of the Study

The purpose of this study is to determine the effects of problem-solving strategy on students' motivation and achievement in Physics in senior secondary schools in Jos, Plateau State, Nigeria. Specifically, the objectives are to:

1. Determine the difference in the pretest mean score of physic students in the experimental and control groups taught physics with problem solving strategy and those taught with lecture method.
2. Determine the difference in the posttest mean score of physics students in the experimental and control groups taught physics with problem solving strategy and those taught with lecture method.
3. Determine the difference in the posttest mean score of male and female physic students taught physics with problem solving strategy.
4. Determine the effects of problem-solving strategy on students' motivation towards studying physics in senior secondary schools.

Research Questions

The following research questions guided the study:

1. what is the difference in the pretest mean score of physics students in the experimental and control groups taught physics with problem solving strategy and those taught with lecture method?
2. what is the difference in the posttest mean score of physics students in the experimental and control taught physics with problem solving strategy and those taught with lecture method?
3. what is the difference in the posttest mean score of male and female physics students taught physics with problem solving strategy?
4. what is the effects of problem-solving strategy on students' motivation towards studying physics in senior secondary schools in Jos?

Null Hypotheses

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

1. there is no significant difference in the pretest mean score of physic students in the experimental and control groups taught physics with problem solving strategy and those taught with lecture method.
2. there is no significant difference in the posttest mean score of physic students in the experimental and control taught physics with problem solving strategy and those taught with lecture method
3. there is no significant difference in the posttest mean score of male and female physic students taught physics with problem solving strategy
4. there is no significant effects of problem-solving strategy on students' motivation towards studying physics in senior secondary schools

Methodology

This study adopted the quasi-experimental design specially the pretest-posttest control group design. The subjects were split into two groups which are experimental group and control group. A pretest was administered to both groups before administering any treatment so as to determine entry behavior of the students and determine difference in pretest scores between the two groups. After treatment had been administered, a posttest was given to both groups. The aim of this was to compare the posttest scores of the experimental and control group. The sample of the study was drawn from two (2) coeducational secondary schools in Jos. A total of hundred (100) students and intact classes of the school were used.

One of the schools was assigned experimental group and was exposed to treatment using problem-solving strategy to teach three concepts in mechanics: equations of motion, momentum and machines. The other school was assigned control group and was also taught the same concepts as the experimental group using conventional lecture method. Two instruments were used to obtain data from the subjects. The instruments are physics achievement (PAT) and physics motivation rating scale PMRS). The PAT consisted of 25

multiple choice objective test items meant to determine students' problem-solving ability in relation to achievement in physics. The Physics Motivation Rating Scales (PMRS) consisted of 20 items statement meant to determine students' motivation in relation to problem-solving in physics. The two groups were exposed to treatment for six weeks. After the instruction, a post-test was administered on both the experimental and the control groups. The questions in the PAT (posttest) are the same in that of PAT (pretest) only that they questions were reshuffled to avoid students guessing. Administration of the PAT was done in each of the sampled schools according to specified date. Time allotted to answer the questions was 50 minutes. The students in the groups (experimental and control) were also given the PMRS questionnaire to respond to. The two instruments for data collection were validated by three experts from the Departments of Science and Technology (physics Education), educational foundation (Test, measurement and evaluation) and physics department, University of Jos. Their corrections and inputs were taken into consideration before final production of the instrument for administration. The reliabilities of the instruments (PAT and PMRSQ) were established using SPSS version 22 employing cronbach alpha method of computing reliability. A trial test was carried out with 30SSII physics students in one school in Bassa LGA, Plateau state. The data obtained was analyzed and the reliability for the PAT and PMRS were found to be 0.81 and 0.71 respectively. In analyzing the data, the research questions were answered using mean scores while t-test was used to test the null hypotheses since the intended to determine whether any difference existed between two samples on a given dependent variable.

Results

Research Question 1: What is the difference in the pretest mean score of physic students in the experimental and control groups taught physics with problem solving strategy and those taught with lecture method.

Table 1: Pre-test mean scores of physics students in the experimental and control group

Group	N	$\bar{X}$	SD
Experimental	50	50.37	13.72
Control	50	50.29	14.87

The results in Table 1 revealed a mean score of 50.37 and 50.29 and the standard deviations of 13.72 and 14.87 for the experimental and control group respectively. This means that there was no difference in the pre-test academic achievement means scores of physics students in experimental and control groups before exposure to treatment using problem solving method.

Research Question 2: What is the difference in the posttest mean score of physic students in the experimental and control groups taught physics with problem solving strategy and those taught with lecture method

Table 2: Post-test mean scores of physics students in the experimental and control groups

Group	N	$\bar{X}$	SD
Experimental	50	62.43	13.79
Control	50	48.98	12.66

Table 2 revealed that the post-test mean score of 62.43 for students taught physics using problem solving method of teaching was higher than the mean score of those not exposed to the technique computed as 48.98. This implies that the mean score of students in the experimental group was significantly higher as a result of the treatment they were exposed to.

Research Question 3: what is the difference in the posttest mean score of male and female physic students taught physics with problem solving strategy?

Table 3: Post-test mean scores of male and female physics students in the experimental group

Gender	N	$\bar{X}$	SD
Male	22	65.73	13.55
Female	28	64.43	10.17

The findings in Table three above showed a post-test mean score of 65.73 and 64.43 for male and female students taught physics in the experimental group. The result indicated that there was no significant difference in male and female academic achievement means scores. However, male students mean score was slightly higher than that of female students.

Research Question 4: What is the effect of problem-solving strategy on students' motivation towards studying physics in senior secondary schools in Jos?

Table 4: Mean rating of extent to which problem solving strategy affect student motivation toward physics

Statement of Items	$\bar{X}$	SD	Decision
I am excited when is time for physics class	3.73	1.43	Agree
I like physics because my teacher uses problem solving method	3.14	0.62	Agree
I solve most of my class work my	3.02	0.77	Agree

self			
I feel dissatisfied when I get low grades in physics	3.33	0.67	Agree
I like physics because my teacher always encourage me to learn on my owns	3.44	0.56	Agree
I have confident that I will do well in physics	2.90	0.75	Disagree
I like physics because it deals with practical skills	3.59	0.59	Agree
I do not find it difficult to ask the teacher questions on topic taught	3.48	0.59	Agree
I perform poorly in physics because of the way my teacher solve physics problems	2.91	0.99	Disagree
I try to solve assignment given to me by my teacher	3.02	0.74	Agree
Cumulative Mean	**= 3.26**		

Criterion Mean = 3.0

The Table above revealed that the cumulative mean of items which is 3.26 is greater than the criterion mean of 3.0.This implies that all the items are problem-solving related factors that have effect on students motivation toward learning physics in the study area .The finding revealed further that most students are excited when it is time for physics class (x=3.73) and that they feel dissatisfied when they get low grades in physics (x=3.33).

Null Hypotheses Testing

$H0_1$: There is no significant difference in the pretest mean score of physics students in the experimental and control groups taught physics with problem solving strategy and those taught with lecture method.

Table 5: Independent t-test result of difference in pre-test mean scores of experimental and control groups

Group	**n**	$\overline{X}$	**SD**	**Df**	**t**	**P**	**α**	**Decision**
Experimental	50	50.29	13.72					
			+	98	3.53	0.59	.05	Not Sig.
Control	50	51.37	14.87					

p>0.05

Table 5 revealed that t = 3.53 and the probability value is 0.59.Since p-value is greater than 0.05 used as the level of significance, it was concluded that there is no significance difference between the pre-test mean scores of physics students in the experimental and control group.

$H0_2$: There is no significant difference in the posttest mean score of physic students in the experimental and control taught physics with problem solving strategy and those taught with lecture method

Table 6: Independent t-test result of difference in post-test mean scores of experimental and control groups

Group	n	$\bar{X}$	SD	df.	t	P	α	Decision
Experimental	50	62.43	13.79					
				98	7.12	.000	.05	Sig.
Control	50	48.98	12.66					

$p<0.05$

The results above showed that the experimental group had a post-test mean score of 62.43, while the control group had 48.98 as its post-test mean score. The p-value is 0.000, while t = 7.12.Since p<0.05 the Ho is rejected and concluded that there is a significant difference between the post-test mean score of students in the experimental and control group.

$H0_3$: There is no significant difference in the posttest mean score of male and female physic students taught physics with problem solving strategy.

Table 7: Independent t-test result of difference in post-test mean scores of male and female students using problem solving strategy

Gender	n	$\bar{X}$	SD	df.	t	P	α	Decision
Male	22	65.73	13.55					
				48	2.39	.70	.05	Not Sig.
Female	28	64.43	10.17					

$p>0.05$

The findings from the Table revealed a mean score of 65.73 and 64.43 for male and female physics students using problem solving strategy. Thus, since t =2.39 and p =0.70 which is greater than 0.05 used as the level of significance, Ho is rejected and concluded that there is no significant difference between the post-test mean scores of male and female students in the experimental group using problem solving strategy.

$H0_4$: There is no significant effect of problem-solving strategy on students' motivation towards studying physics in senior secondary schools

Table 8: Dependent t-test Result of Difference in effects of problem-solving strategy and motivation strategy towards studying physics in senior secondary schools

Variable	n	$\bar{X}$	SD	t-cal.	P	α	Decision

problem solving		3.02	1.76				
Strategy	100			.670	.026	.05	Significant
motivation strategy		2.29	1.75				

p<.05

Table 8 showed that t(100=.670,p=.026),which means that p<0.05 used as the level of significance. Based on this the Ho was rejected and it was concluded that there is a significant effect of problem solving technique and motivation towards the study of physics. This implies that the teacher use of problem solving strategies in the teaching of physics has significant effect on students' motivation in the study of physics in Jos.

Discussion of Findings

The findings from the analysis of research question one showed that the physics students' academic achievement mean scores in experimental and controlwas not different significantly. The result revealed that $\bar{X}$ = 50.37 and $\bar{X}$ =50.29 experimental group and control group respectively. Their standard deviations are 13.72 and 14.87 which indicated that the mean difference is insignificant. This implies no significant difference in mean achievement score pretest and is supported the findings of Gamze, Serapa and Mustafa (2008) who in their study found out that experimental and control group were equal in problem solving before the intervention strategies.

The test of null hypothesis 1 revealed that p = 0.59 and t =3.53, which means that is p>0.05 and there was no evidence to reject the Ho. This result showed that there was no significant difference between the mean academic achievement scores of physics students in the experimental and control group. However, the result of analysis for hypothesis two revealed that p<0.05.That is 0.000 is less than 0.05 and Ho was rejected. This means there was a significant difference between the post-test mean academic scores of physics students in the experimental and control group with those in the experimental group achievement higher significantly. Thus, Ho was significant at 0.05 level of significant. This agreed with findings of Gamze, Serap and Mustafa(2008) study on effective of problem-solving instruction on achievement that students in the experimental group scored significantly higher than those in the control group as t(72) =5.24p<0.05.

The results of analysis of research question two on the other hand showed that the experimental group students exposed to Problem Solving Strategy of teaching had a higher post-test mean score (= 62.43) than the mean score for the control group computed as = 48.98, that were not exposed to the same treatment, but taught physics using the lecture method. This therefore means that problem-solving method is an effective teaching strategy that enhances students' motivation and achievement in physics. This supported the findings of Thelma (2014) on effect of structured problem-solving strategy on performance in physics that the experimental and control groups were equal in their performance in Physics at the beginning of the experiment. Furthermore, the analysis of difference in male and female academic achievement of physics students exposed to the treatment of teaching using the

problem-solving approach revealed that male students had a higher post-test mean score than their female counterpart. This implies that though both groups were exposed to the problem-solving method, male students performed better in terms of their achievement scores in physics.

Null Hypothesis 2 on Table 6 indicated the significant difference between the post-test mean score of student in the experimental and control groups. The result of research question three Table 3 show that there was a significant difference in male and female achievement means scores in favour of the female students.More so, the result from null hypothesis 3 revealed that there was no enough evidence to reject the Ho. That is, the null hypothesis was not rejected on the ground that the p-value of 0.700 computed is greater than 0.05 used as the level of significance. Thus, it was concluded that the mean scores of male and female students taught physics using problem solving method do not differ significantly. However, it was found out that male students post-test were marginally higher than that of their female counterpart. This is in line with the findings of Gok and Silay (2009) who in their study on effect of problem solving on strategy on students achievement, attitude and motivation found out that gender variety did not cause any important effects on the post-test achievement of students in physics as $p>.05$.

Table 4 answers research question 4. It was found that most students are excited when it is time for physics class. The report showed that students like physics because their teachers used problem-solving method, as they solve their problems themselves. Moreover the students agreed that they are always encouraged by their teachers. It was found out from the study that the students always solved their assignment themselves because they do not find it difficult to ask their teachers for more explanation on lessons taught. This agreed with the view of Olaniyan, Omosewo and Nwankwo (2015) that for teaching and learning to be done in a classroom setting, it is important to ensure that the two-way communication channel exists between the teacher and the students. Students are expected to develop cognitive and practical skills that will enable them to apply their knowledge to explain phenomena that happen around them and to solve the problem. The findings of null hypothesis 4 Table 8 shows that there as was a significant effect of problem solving strategy on student motivation towards physics.

Conclusion

The effects of problem-solving strategy on motivation and achievement on senior secondary school students in physics has indicated that physics students taught using problem-solving strategy (the experimental group) achieved higher academically than those taught physics using lecture method (the control ground). The study also found that the strategy is gender friendly as there was no significant difference in the mean academic achievement of the students. Also there was no significant difference in academic achievement of public and private school students in Physics. This suggest that problem-solving strategy can be used to enhance effective teaching and learning of physics even at higher level of education since secondary school is the foundation for higher learning.

Motivation is also a key factor to students achievement in physics based on the use of problem solving strategy

Recommendations

Based on the findings of this study, the following recommendations are proffered:

1. Physics teachers should always adopt appropriate teaching methods in order to facilitate teaching and learning of physics concepts in secondary schools.
2. School administrators should from time to time organize seminar/works for physics teachers aimed keeping them abreast.
3. Students should constantly read and solve problems so as to become effective problem-solvers.

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