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Effectiveness of Physics Problem Solving Approach on Students' Gender

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ABSTRACT

This study investigated the effectiveness of the physics Problem Solving Approach (PPSA) on students' gender. The research was carried out in Isin and Irepodun Local Government Areas of Kwara South Senatorial District. Eighty Senior Secondary School two (SSII) physics students participated in the study. Two research hypotheses were formulated, one of which was that there is no significant difference in the post-test mean scores of male and female students taught with Physics Specific Problem-Solving Approach. A 30–item objective question and Eight-item essay questions wereused as pretest and post-test for the students. Descriptive statistics were used to answer research questions while ANCOVA statistic was usedto test the two hypotheses at 0.05 level of significance. The results of analyses showed that the mean gain of male (8.00) and female (2.27) students taught with Physics Problem-Solving Approach was higher than male (1.45) and female (1.33) students taught with Lecture Method. There was also significance difference in the performance of male and female students taught with the PhysicsProblem Solving Approach,F (1, 37) = 28.027, p < 0.05. Among the recommendations was that teachers should adopt the use of PPSA in teaching physics in schools.

Key words: Gender, Problem solving, Physics problem solving approach, Achievement in physics

Introduction

Education is the key to national development, education is also essential to economic and social development. The economic competitiveness of any country depends on the quality of education in that country (Akamobi & Akamobi, 2014). The main emphasis of education is to train the citizens to become useful members of the society considering the nature of prevailing circumstances that are challenges to the society (Adida, Asinde & Asinde, 2014).

Knowledge of science is also indispensable in the development of a nation. It is an instrument for change and the gateway for socio-economic achievement, industrial development and the path to self-reliance (Adejoh, 2014).The reasons for teaching science in schools are many, some of which are to help children explain events in nature, to enable them to think and reason in a logical manner and to develop their physical and social skills among others. Physical science as taught at the SeniorSecondary School (SSS) levels are Biology, Chemistry and Physics. Physics deals with matter in relation to energy. The fields of physics are many,

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ranging from acoustics to atomic physics, electromagnetism, fluid dynamics, molecular physics, plasma physics, quantum physics, nuclear physics, solid state physics, to optics e.t.c.Optics and its related concepts are very important aspects of physics in the National Curriculum for Senior Secondary Schools.

There are many problems of teaching physics in secondary schools. Some of which are; dependence on the teachers, docile learning, miss-representation, development of passivity, dwindling interest of students, poor performance, e.t.c. Factors contributing to these problems are many, one of them is the method adopted by the teachers in teaching physics. The present century has witnessed different advocates of moving from formal to informal methods of teaching physics. Ugwu (2014) noted that the problem encountered during teaching and learning of science concepts by students have resulted in science students perceiving science as difficult. Adejoh (2014) posited that there are many teaching methods available to teach science and that the skillful teacher needs to employ varieties. However current trends in science teaching is for the teacher to use students centered teaching methods.

Adeniran (2013) explains that there are many problem solving approaches that a teacher can use. Among which are means-end-analysis, trial-and-error, brainstorming, morphological box, research and Georg Polya technique of how to solve it. DeMuth (2007) provided a specific problem solving model for teaching physics. Problem solving is an activity based approach to learning. It refers to any activity in which both the cognitive representation of prior experience and the components of a current problem situation are reorganize to achieve a designated objective. Problem solving is a general characteristic of motor learning and of the solution of most mazes and complex puzzle box problems. It occurs most efficiently when learners are aware of the direction and extents of their deviations from the desired solution and are permitted to execute the necessary correctionthemselves. The stages in the physics problem solving approach as posited by DeMuth (2007) are focus the problem, describe the physics, plan the solution, execute the plan and evaluate the answer. DeMuth (2007) problem solving model for physics was adopted for this study.

Tunde-Awe (2014) posited that issues related to gender and differences in academic performance have been of interest to many researchers. In many societies, different roles are ascribed to men and women and differences also exist in their access to control of resources. Adeniran (2014) discussed the result of a quasi-experimental study on task approach as an innovation for facilitating meaningful learning in physics. The study comprised of 55 male and 45 female secondary school II students in Kwara South Senatorial District. The instrument was a 20-item objective question. The result of descriptive analysis indicated that the female students performed better than the male students taught using the task approach method of teaching. There was no significant difference in the posttest mean cores of male and female students exposed to task approach.

Bot and Nwamaka (2014) noted that the cooperative method can be used to help students achieve better result in mathematics and science. In a quasi-

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experimental research carried out in Bichi Local Government Area of Kano state in which 100 senior secondary class two students were involved. Students in the cooperative class performed better than those in control group. Male students also did better than the female students in the mathematics achievement test. But the mean achievement scores between male and female students was statically significant. This means male students are superior to female in algebra.

Mangut and Anko (2014) conducted study on the effect of oriented conceptual change instruction on secondary school students' achievement in physics in Northern Zone of Plateau state. The result of the quasi-experimental study showed that physics students taught using conceptual change instruction performed better than those taught with lecture method. Female students in the experimental group performed better than the male students, and there was no significant difference in the performance of physics students in the oriented conceptual change and lecture method. Adeniran (2015) investigated the effects of cooperative learning on the performance of physics students in Kwara State and found that both male and female physics students benefitted from the study. Male students had the higher posttest mean score than the female students and the result of ANCOVA indicated that there was no significant difference in the performance of male and female physics students.

This study also examined the effectiveness of physics problem solving approach on the performance of male and female students in Kwara State, Nigeria.The study would benefit the teachers and the students. It would enable the teachers to know the gender difference in the performance of the students and hence the need to use gender friendly method during the teaching of physics, as a result of which students (male and female) performance would be enhanced.

Purpose of the Study

The purpose of the study in this paper is find out the effect of the physics problem solving approach on the performance of male and female students in Optics. Specific purposes are to find the:

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1. pretest and posttest mean scores of male and female students in PPSA and LM?
2. difference in the posttest mean scores of male and female students taught using the physics problem solving approach.

Research Questions

1. What is the pretest and posttest mean scores of male and female students taught in PPSA and LM in the optics performance test?
2. What is the difference in the posttest mean scores of male and female students taught using the physics problem solving approach in the optics performance test?

Hypotheses

H_{01} There isno significant difference in the posttest mean scores of male and female students taught using the physics problem solving approach and lecture method in the optics performance test.

H_{02} There is no significant difference in the posttest mean scores of male and female students taught using the physics problem solving approach in the optics performance test.

Methodology

Research Design

This study was a quasi-experimental, non-randomized, pretest, posttest control group design.Intact groups of the students were used. The physics problem solving approach and the lecture method were used as treatments at gender levels of male and female students.DeMuth (2007) also developed the Physics Specific Approach. It was referred to as the Minnesota Model. He believes that each profession has its own specialised knowledge and patterns of thought. The knowledge and thought process used in each of the steps will depend on the discipline in which one operates. DeMuth (2007) physics problem solving model was adopted for this study.

Population

The population was made up of all the male and female Senior Secondary (SS) II physics students in Kwara South Senatorial district of Kwara State.

Sample and Sampling Techniques

The sample of the study consisted of 80SSII physics students from four schools in Kwara south senatorial district. The sample was made up of 43 male and 37 female students. The four schools used for study are the schools that met the criteria for their selection. The schools are located in Isin and Irepodun Local Government Areas (LGA) of Kwara State. Intact classes of students were used in each school.Two schools each represented PPSA and LM.

The choice of SSII students were made because the students have been exposed to the pre-requisite concepts necessary for understanding the treatment concepts, e.g. meaning of waves, types and propagation of waves and were not under the pressure of preparing for external examinations.

The selected schools met the following criteria.

i. Teachers have not taught the concept selected for the study.
ii. There was evidenceof students' enrolment for physics at the SSII level.
iii. The schools were coeducational with representation of both sexes.
iv. The laboratory was fairly equipped.

Research Instrument

The instruments used for the study were the Optics Performance Test (OPT) and lesson notes on the physics problem solving approach and the lecture method. The OPT

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consisted of 30 objective questions and eight-item essay questions in Optics.

Validation of Research Instruments

The draft of the OPT and the lesson notes were given to experts in physics, and science educators for corrections. Their criticism and review greatly improved both the face and content validities of the instruments. To find the reliability of OPT, two secondary schools were used at a different LGA in Kwara State. Test was administered on SSII students in two schools in Offa LGA. Kuder Richardson, KR_{21}, was used to find the reliability of the test. The value of reliability was 0.72, which is high enough for the instrument to be used.

Treatment Procedure

The treatments for the study were the physics problem solving approach and the lecture method. The regular physics teachers were used for the study. The teachers were trained for one week after which they were given the validated lesson notes. The study covered four weeks. Pretest was conducted for the SSII physics students before treatment. The teachers followed the validated lesson notes during teaching. By the end of the fourth week, posttest was conducted using OPT, for both the experimental and the control groups.

Data Analyses Technique

SPSS version 17 statistical package was used to analyse the data collected. Research questions were answered using mean and standard deviation while the hypotheses were tested using ANCOVA at $p < 0.05$.

Results

The scores of the students were first subjected to mean, standard deviation and ANCOVA statistics for analyses purpose.

Research Question 1

What is the pretest and posttest mean scores of male and female students in PPSA and LM in the optics performance test?

Table 1

Analysis of Mean and Standard Deviation of Male and Female Students' Scores Taught Using the PPSA and LM

	Gender	Mean	Pretest	Posttest	Mean gain score
PPSA	Male	Mean	12.86	20.86	8.00
		N	21	21	
		SD	6.92	2.94	
	Female	Mean	12.05	14.32	2.27
		N	19	19	
		SD	3.87	4.62	
	Gender	**Mean**	**Pretest**	**Posttest**	**Mean gain score**

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	Male	Mean	12.73	14.18	1.45
		N	22	22	
LM		SD	2.31	4.15	
	Female	Mean	12.06	13.39	1.33
		N	18	18	
		SD	1.73	1.69	

Data in Table 1 showed thatthe pretest mean scores of male and female students taught in the PPSA are m = 12.86 and m = 12.05 respectively while the posttests mean scores for these students are m = 20.86 and m = 14.32 respectively. The pretest mean scores of male and female students taught in LM are m = 12.73 and m = 12.06 respectively, while the posttest mean scores of male and female students taught in LM are m = 14.18 and m = 13.39 respectively.

Research Question 2

What is the difference in the posttest mean scores of male and female students taught using the physics problem solving approach in the optics performance test?

The posttest mean score of male students in the PPSA was 20.86, while that of the female was 14.32. Therefore, the difference in mean scores of both male and female students taught in PPSA was 6.54.

Hypothesis 1

There is no significant difference in the posttest mean scores of male and female students taught in the physics problem solving approach and the lecture method.

Table 2: ANCOVA Computation on Male and Female Students' Performance in the Physics ProblemSolving Approach and Lecture Method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	741.574[a]	4	185.393	14.397	.000
Intercept	1935.016	1	1935.016	150.263	.000
Pretest	.413	1	.413	.032	.858
Treatments	286.977	1	286.977	22.285	.000
Gender	263.368	1	263.368	20.452	.000
Treatments * Gender	164.046	1	164.046	12.739	.001
Error	965.814	75	12.878		
Total	21647.000	80			
Corrected Total	1707.388	79			

a. R Squared = .434 (Adjusted R Squared = .404)

Table 2 shows the analysis of covariance on the posttest mean scores of male and female students taught using the Physics ProblemSolving Approach and lecture method. F (1, 75) = 20.452, $p < 0.05$, the null hypothesis was rejected. The ANCOVA showed a significant

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difference in the posttest mean scores of the male and female students taught using the PPSA and LM.

Table 3: Scheffé Post Hoc Test on the Performance of Male and Female Students in PPSA and LM

Treatment	(I)Gender	(J) Gender	Mean Difference (I-J)	Std. Error	Sig.
PPSA	Male1	Female1	4.50	1.878	.134
		Male2	9.06*	1.810	.000
		Female2	10.85*	1.906	.000
	Female1	Male1	-4.50	1.878	.134
		Male2	4.56	1.858	.121
		Female2	6.35*	1.951	.019
LM	Male2	Male1	-9.06*	1.810	.000
		Female1	-4.56	1.858	.121
		Female2	1.79	1.886	.824
	Female2	Male1	-10.85*	1.906	.000
		Female1	-6.35*	1.951	.019
		Male2	-1.79	1.886	.824

Based on observed means. The error term is Mean Square(Error) = 35.198.
The mean difference is significant at the 0.05 level.
* the mean difference is significant at 0.05 level

The result of the Post Hoc analysis showed there was significant difference in the performance of the male students (male1) in PPSA and the male (male2) and female students (female2) in LM. The performance of female students in PPSA with a mean difference (i-j) of 10.85 had the highest effect on the performance of other students in OPT.

Hypothesis 2

There is no significant difference in the posttest mean scores of male and female students taught using the physics problem solving approach.

Table 3: ANCOVA Computation on Male and Female Students' Performance in the Physics Problem Solving Approach

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	430.625[a]	2	215.312	14.409	.000
Intercept	1881.854	1	1881.854	125.939	.000
Pretest	3.802	1	3.802	.254	.617
Gender	418.790	1	418.790	28.027	.000

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Error	552.875	37	14.943
Total	13586.000	40	
Corrected Total	983.500	39	

a. R Squared = .438 (Adjusted R Squared = .407)

Table 3 shows the analysis of covariance on the posttest mean scores of male and female students taught using the Physics Specific ProblemSolving Approach.

F (1, 37) = 28.027, p < 0.05. Analysis of covariance showed a significant main effect of PPSA on gender, therefore the null hypothesis was rejected.

Summary of Findings

The followings are the findings of this study.

1. the pretest mean scores of male and female students taught using the PPSA are
   m = 12.86 and m = 12.05 while their posttest scoreswere m = 20.86 and 14.32 respectively.The pretest mean scores of male and female students taught using the LM were m = 12.73 and m = 12.06 while their posttest scores were m = 14.18 and 13.39 respectively.
2. The difference in the posttest mean scores of male and female students taught using the Physics ProblemSolving Approach was6.54.
3. there was significant difference in the posttest mean scores of male and female students taught using the physics problem solving approach and the lecture method, F (1, 75) = 20.452, p < 0.05consequently, the null hypothesis was rejected.
4. The result of the Post Hoc analysis showed there was significant difference in the performance of male students (male1) in PPSA and the male (male2) and female students (female2) in LM. The performance of female students in PPSA with a mean difference (i-j) of 10.85 had the highest effect on the performance of other students in OPT.
5. there was significant difference in the posttest mean scores of male and female students taught using the physics problemsolving approach.F (1, 37) = 28.027, p < 0.05consequently, the null hypothesis was rejected.

Discussion

The result of the analyses based on research questions one and two indicated that the physics problem solving approach improved the performance of the students in physics. Both the male and female physics students benefited from the study, but the male students achieved better than the female students PPSA. Both and Nwamaka (2014) found that cooperative learning strategy helped students to achievement better in mathematics than the conventional teaching method. Male students also did better than the female students in mathematics when taught with cooperative learning. Adeniran (2014) and Mangut and Anko (2014) noted that when task approach and oriented conceptual

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change were used respectively as experimental groups, physics students were able to perform better than the conventional methods.

The result of ANCOVA analyses showed that there was significant difference in the posttest mean scores of male and female students taught PPSA and LM and there was also significant difference in the posttest mean scores of male and female students taught using PPSA. Adeniran (2014), Mangut and Anko (2014)and Adeniran (2015) found no significant difference in the performance of physics students when exposed to task approach, oriental conceptual change instruction and cooperative learning respectively. It is generally believed that students centered methods of teaching may improve the performance of students when students are exposed to them. The efficacy of these methods will depends on the teachers' ability to use them appropriately.

Conclusion

What is learnt is a function of how it is taught,when two teachers teach the same group but with different methods, the learning outcome may vary. This study showed that both male and female physics students performed better in the physics problem solving approach compared to lecture method. The male physics students also achieved significantly better than the female physics students taught using the physics problem solving approach. Based on the findings, it is concluded that physics problem solving approach is more effective than lecture method.

Recommendations

The following recommendations are based on the findings of this study.

1. Physics problem solving approach is effective for teaching physics. For this reason, teachers should adopt it to help improve the achievement of students in physics.
2. Teachers that find it difficult to use the physics problem solving approach should be trained on how to use it through seminars and workshops.
3. Research should be conducted to find the effect of the physics problem solving approach in other different areas of physics based on interest and ability at different levels of education.

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