RELATIONSHIP BETWEEN PROBLEM-SOLVING ABILITY AND ACHIEVEMENT IN PHYSICS AMONG SENIOR SECONDARY SCHOOL STUDENTS IN OSUN STATE, NIGERIA

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Abstract

This study examined the problem-solving skills of students in relation to their achievement in Physics. An ex-post facto research design was adopted for the study. A sample of three hundred and two (302) students was drawn from a total population of fourteen thousand, three hundred and twenty two (14,322) senior secondary school II students using stratified random sampling technique. Two instruments: Test of Problem-Solving ability in Physics (TPSAP) and Test of Achievement in Physics (TAP) with reliability indices of 0.78 and 0.87 respectively, were used for the study. The results of the study revealed that there was significant relationship between students' problem solving ability and achievement in Physics for all students ($r = 0.54$, $p < 0.05$), male students only ($r = 0.56$, $p < 0.05$), and female students only ($r = 0.53$, $p < 0.05$). It was concluded that problem-solving ability is a critical variable of students' achievement in Physics.

Backrground

Science and technology have become an integral part of the world's culture, which any country dare not overlook because of the fear of the risk of remaining backward among nations. This why scientific and technological breakthrough is usually the goal of any developing nation like Nigeria. The view has been expressed that for Nigeria to develop her science and technology, the foundation for developmental processes must be laid in the secondary schools (Ozoro, 1997). Otuka (1983) reported two noteworthy remarks made on the importance and relevance of Physics to technology. The remarks were: (i). 'the measures for promoting Physics have turned out to be the sine qua-non for rapid acquisition of technological know-how in most countries of the world' and (ii). 'the technological potential of a country is more accurately gauged by the quality of its physics education than by any other single index such as the size of its population, for without physics, technological culture cannot really take root no matter the amount of imported technical expertise'. These statements point to the fact that for Nigeria to develop scientifically and technologically, the teaching and learning of physics should be encouraged especially when students first encounter the subject at the secondary school level.

Physics is a science subject that deals with the fundamental constituents of the universe, the forces they exert on one another, and the effects of these forces. According to Weaver (1965), physics is the most basic of science fields and one with the lowest population of teachers and learners. This statement is still valid till date. Using data obtained from the American National Centre for Education Statistics, Layman (1983) noted that only 20 percent of graduating high school seniors had taken a physics course, and if 60 percent of the students who started high school graduate, then, about 12 percent of high school seniors in United States of America take a physics course during their schooling.

In spite of the importance of physics to technological development, it appears that all is not well with students' enrolment and achievement in the subject at the secondary school

level in Nigeria. Some studies have shown that physics has a relatively low population index at the secondary school level in Nigeria. (Fasemore, 1970; Adejumobi, 1976). Ho and Boo (2007) discussed that in many countries, there has been a decline in the number of students wishing to continue with physics. The West African Examinations Council (WAEC)'s statistics indicates a continuous decline in enrolment for school certificate physics examination in Nigeria. Between the year 2002 to 2006, there was a consistent decline in enrolment of Nigerian candidates for physics. It is also very clear that out of the three science subjects of Physics, Chemistry and Biology, physics has always been recording the least entry each year (Table 1).

There are also empirical evidences that Nigerian senior secondary school students perform below expectation in physics in their school certificate examinations. Nneji (1998) showed that the performance of students in the West African Senior School Certificate Examination (WASSCE) in science between 1988 and 1992 was poor. The average performance showed that 8.27% of the students had credit while 31.2% had passes. Ali (1990), Okebukola (1997), Nneji (1998), Ogunleye (2000) and Umeh (2002) were all of the opinion that students' performances in the science subjects were poor. From 2002 to 2006, the percentage pass at credit level recorded in physics were 47.66%, 47.56%, 51.02%, 41.5%, and 58.06% respectively (table 1). In the area of gender, Bamigblala (2006), found out that the participation and performance of girls in sciences especially physics was low compared to that of their male counterparts. Reasons advanced for the dismal performance of students in physics include: inadequately qualified teachers, inadequate motivation for students, students' poor mathematical background, poor methods of teaching, all of which result in poor problem-solving ability. Specifically, a report of the Science Teachers Association of Nigeria (STAN) workshop on physics held at Osogbo in 2004 stated that students perform poorly in physics due to lack of proper teaching, and poor exposure of students to practicals.

Table 1: Nigerian candidates' enrolment and performance in the May/June West African Senior School Certificate Examination (WASSCE) conducted by the West African Examinations Council (WAEC) between 2002 and 2006.

Subjects	**Year**	**Total entry**	**Total pass at credit level (A1 to C6)**	**% pass at credit level (A1 to C6)**
	2002	1,047,235	328,727	31.39
	2003	931,219	385,525	43.14
Biology	2004	834,945	258,945	30.83
	2005	106,100	37,920	35.74
	2006	984,000	484,423	49.23
	2002	309,120	107,884	34.89
	2003	288,324	146,757	50.98
Chemistry	2004	275,078	107,005	38.97
	2005	136,500	69,533	50.94
	2006	135,000	60,615	44.90
	2002	298,059	142,055	47.66
	2003	280,880	133,557	47.56
Physics	2004	270,028	137,768	51.02
	2005	124,500	51,668	41.50
	2006	116,000	67,350	58.06

Source: Research division, West African Examinations Council, Yaba, Lagos.

Problem solving can be defined as whatever action a person takes to bridge the gap between the anticipated solution and the problem itself. Problem solving ability is the ability to bridge the gap between a problem and a solution by using information (knowledge) and reasoning. DeMuth (2007) listed five steps to Physics Specific Problem Solving Approach: Focus the problem, describe the physics, plan the solution, execute the plan, and execute the answer.

This research work on problem solving in physics is based on Pascual-Leone's information processing theory (Pascual-Leone, 1969, 1970). This theory is a neo-piagetian paradigm which has been used as a framework to investigate scientific problems (Onwu, 1981, 1982; Niaz, 1987, 1988, 1996; Tsarparlis & Angelopoulos, 2000). This theory makes the assumption that in solving a problem, the individual's psychological system functions as a set of processes, which uses the information presented to it more than it reacts to it. The theory stipulates that when confronted with a problem or learning situation, learners use a definite information seeking strategy that is guided by their current hypotheses. The learning theory of Gagne, Ausubel, and Piaget also provide theoretical framework for studies on problem solving (Adesoji, 1991). The need for prerequisite concepts in order to facilitate the understanding of higher concepts in a learning hierarchy was stressed by the trio.

The Physics content chosen for this study is 'mechanics'. This is because mechanics is more than just one of the domains of physics. Mechanics defines the main tools in physics and presents the most universal law of nature, the Newton's law of gravitation which is applicable to all masses (Galili, 1995). This is why it always opens any physics curriculum. The major concepts the study focused on are Motion and Conservation Principles with particular reference to Newton's Laws of Motion and their prerequisite concepts.

Some studies have been conducted in Nigeria in the area of problem solving in science. Bajah and Bello (1987) sought to find out the effect of enhanced problem solving instructional strategy on chemistry achievement using a five step problem solving model, They found out that the model coupled with practice, verbal feedback and remedial instruction enhanced students' chemistry achievement significantly. Efforts had also been made to formulate and trial test some problem solving models in physics. (Egbugara, 1989; Ogunneye, 1993). Ahiakwo (1991) conducted a study to find out the extent to which students' cognitive style influenced their problem-solving ability. The overall result of the study showed that although the subjects performed poorly, the analytic style was more effective. He concluded that the subjects had difficulties not only with the recall of appropriate chemical information, but also with the methods or strategies required to reason through the problem. This study therefore examined students' problem-solving ability in relation to their achievement in physics at the senior secondary school level.

Research Hypothesis

The following hypotheses were generated and tested for the study at 0.05 alpha level.

1. There is no significant relationship between students' scores in the Test of Problem-Solving Ability in Physics (TPSAP) and their scores in the Test of Achievement in Physics (TAP).
2. There is no significant relationship between male students' scores in the Test of Problem-Solving Ability in Physics (TPSAP) and their scores in the Test of Achievement in Physics (TAP).

3. There is no significant relationship between female students' scores in the Test of Problem-Solving Ability in Physics (TPSAP) and their scores in the Test of Achievement in Physics (TAP).

Methodology

This study adopted the ex-post facto research design since the effects of the independent variable on the dependent variable are already in existence. There was therefore no manipulation of the independent variable.

Sample

The sample for this study comprised of three hundred and two (302) senior secondary school class two (SS II) students selected from a total population of fourteen thousand, three hundred and twenty two students (14,322). From this population, twelve intact physics classes were selected from twelve schools out of thirty nine schools in four local government areas of Osun State. The sample consisted of one hundred and seventy males and one hundred and thirty two females. They have an average age of 16.7 years.

Instrument

Two instruments: Test of Problem-Solving ability in Physics (TPSAP) and Test of Achievement in Physics (TAP) were used for the study. The TPSAP required students to solve some problems in physics and was used to determine their problem solving ability. It contained twenty objective items, ten of which were to test students' attitudes to problem-solving and the remaining ten were based on students' underlying principles for solving problems in physics. It also contained six essay-type questions in problem solving in physics with four items on numerical problems and two items on non-numerical problems. The TAP contained fifty objective items that required students' possession of adequate conception of concepts of the selected topics and good problem solving ability, for the test to be passed well. The questions were adopted from past West African Senior School Certificate Examination (WASSCE) papers and the National Examination Council NECO Senior School Certificate Examination physics papers.

The instruments were validated by one expert in the Department of Physics, and two experts in the Faculty of Education, Obafemi Awolowo University, Ile-Ife. The reliability of the instruments were determined using test re-test method of two weeks interval, and the scores generated in the two administrations were correlated using Pearson Product Moment Correlation Coefficient to obtain reliability indices of 0.78 and 0.87 respectively.

Data Collection

The study lasted for six weeks covering a period of training the research assistants, the field testing, the restructuring of the instruments, and the administration of the instruments for the main study. The main study was carried out in nine intact classes in nine secondary schools in Irepodun, Osogbo and Olorunda Local Government Areas of Osun State. The regular physics teachers in these schools also served as research personnel for the administration of the instruments. The Local Inspectors of Education also assisted as research monitoring officers. A coordination meeting of the researcher with eighteen research assistants and three monitoring officers was held before the main study was conducted. The

two instruments were administered the same day in two sessions as Paper I and Paper II.

Data Analysis

In testing the three hypotheses, students' scores in the TPSAP and TAP were collated in each case of hypotheses 1, 2 and 3, and the Pearson Product Moment Correlation Coefficient formula was employed to find out the correlation between the two sets of scores.

Results and Discussion

The results of the analysis of the data obtained for each of the hypotheses are presented as follows:

Hypothesis 1: There is no significant relationship between students' scores in the Test of Problem-Solving Ability in Physics (TPSAP) and their scores in the Test of Achievement in Physics (TAP). The summary of the results obtained in respect of hypothesis 1 are presented in table 2.

Table 2: Summary of Pearson Product-Moment Correlation between students' scores in the TPSAP, and TAP.

Group	N	ẋ	s.d	r	p
TPSAP scores	302	27.36	7.6	0.543	0.00
TAP scores	302	20.49	5.6		
		P<0.05			

The results presented in table 2 indicate a positive and significant correlation between the scores the of students in the problem solving ability test and the test of achievement in physics. (N=302, r = 0.543; p<0.05). Therefore the null hypothesis of non-significance relationship between students' problem-solving ability and achievement in physics was rejected at 0.05 level of significance.

Hypothesis 2: There is no significant relationship between male students' scores in the Test of Problem-Solving Ability in Physics (TPSAP) and their scores in the Test of Achievement in Physics (TAP). The summary of the results obtained in respect of hypothesis 2 are presented in table 3.

Table 3: Summary of Pearson Product-Moment Correlation between male students' scores in the TPSAP, and TAP.

Group	N	ẋ	s.d	r	p
Male TPSAP scores	170	27.64	7.43	0.556	0.00
Male TAP scores	170	21.30	5.88		
		P<0.05			

Results shown in table 3 indicate a positive and significant correlation between the problem-solving ability and achievement in physics for male students (N=170, r = 0.556, p<0.05). The null hypothesis of non-significant relationship between the problem-solving

ability and achievement in physics for male students was therefore rejected at 0.05 level of significance.

Hypothesis 3: There is no significant relationship between female students' scores in the Test of Problem-Solving Ability in Physics (TPSAP) and their scores in the Test of Achievement in Physics (TAP). The summary of the results obtained in respect of hypothesis 3 are presented in table 4.

Table 4: Summary of Pearson Product-Moment Correlation between female students in the TPSAP, and TAP.

Group	N	ẋ	s.d	r	p
Female TPSAP scores	132	27.00	7.72	0.532	0.00
Female TAP scores	132	19.45	5.08		

P<0.05

Results in table 4 show a positive significant relationship between female students' problem-solving performance and their achievement scores in physics (N=132, r = 0.532, p<0.05). The null hypothesis of non-significant relationship between female students' problem-solving performance and their achievement scores in physics was therefore rejected at 0.05 level of significance.

Based on the results presented, the study found a positive correlation between students' problem-solving ability and achievement in physics. This means that a student who solves problems in physics, numerical and non-numerical will achieve well in physics because solving numerical and non-numerical problems in physics constitutes the major workings in physics. This finding buttresses those of Gbenro (1985) who claimed that students exposed to problem-solving method in Mathematics and science performed better than those exposed to the traditional method. It also corresponds with the finding of Bajah and Bello (1987) who claimed that improved students' problem-solving behaviour enhanced their achievement in chemistry and science. Also, Egbugara (1989) noted that when students are provided a procedural guide in a problem-solving strategy, their problem-solving skills are facilitated and achievement in physics improved. Ahiakwo (1991) showed that the analytic style students are not only better problem solvers in science than the non-analytic style students, the former performed better than the latter. Adesoji (1991) reported that problem solving technique either as a teaching strategy or as a self-learning technique improves students' achievement in chemistry.

Conclusion

The conclusion from this study is that the better the problem-solving ability of students, the better their achievement in physics would be. Attention is therefore needed to improve the problem-solving skills of students in both numerical and non-numerical problems in physics with a view to improving students' achievement.

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