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Constructivist Problem Based Learning Technique and the Academic Achievement of Physics Students with Low Ability Level in Nigerian Secondary Schools

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Abstract
The study investigated the effects of constructivist problem based learning technique on the academic achievement of physics students with low ability levels in Nigeria secondary schools. Pre-test-Post-test control group design was adopted for the study. A purposive sampling technique was used to select 2 schools out of 40-co-educational secondary schools in Taraba state. 105 senior secondary school II physics students were used for the study. Physics Achievement Test (PAT) and physics Ability Level Test (PALT) were used to collect data. The kuder-Richardson coefficient of internal consistency for PAT and PALT were 0.72 and 0.76 respectively. Three hypotheses were tested at $p<0.05$ level of significance using t- test analysis. The result of the findings showed that the physics students with low ability level taught with problem based learning technique performed significantly better than those taught with conventional learning method. Also, student taught with problem based learning technique performed significantly better than those taught with conventional method. There was no significant gender difference in the performance of students taught with problem based learning technique. It is recommended that problem-based learning technique should be used in schools to teach various concepts in physics.

Keywords
Problem-based learning, Conventional, Physics, Low Ability, Achievement.

Introduction

Researchers over the years are faced with finding relevant solutions to the problem of under achievement recorded in physics instruction yearly (Iroegbu, 2004), in spite of the recognitions given to the subject as one of the compulsory science courses at the secondary school level as contained in the National Policy of Education (FGN, 2004), the achievement of students have become worrisome to the generality of the people most especially physics educators and researchers (Akinlaye, 1998). Many researchers have identified different solutions among which is the use of different Instructional methods such as guided discovery, concept mapping, field trip, demonstration method, the inappropriate use of the conventional method of teaching in physics classrooms, large class size, lack of sufficient fund, improper monitoring, lack of good and standard laboratory equipments among others. With the recognition given to physics as the bedrock of science and technology, gaps still exist between curriculum planners' intention and what goes on in the classroom. In a further search for the solution of underachievement, different ability levels of students have been identified as another major factor affecting the performance of students in physics.

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Alant, (2004) studied students' intellectual ability and discovered that students' of varying ability levels performed differently depending on the type of method of instruction. Adesoji (2002) opined that students are not the same especially when we find out the rate at which facts and principles in sciences are been assimilated. This implies that the rate of which an individual performs his specific task differs. The ability level of student is a construct of its academic achievement (Aremu, 2001). Salami (2000) discovered that students' performance depends on its cognitive ability. Studies have shown that learners are qualitatively different in their ability levels and in learning problems (Adesoji, 1997; Chang & Mao, 1998; Iroegbu, 1998). Iroegbu (1998) ascertained that method of instruction can improve the achievement of students with low ability levels). Adesoji (1995, 1997) discovered that problem solving strategies were effective in teaching students of different ability levels.

Okebukola (1992) confirmed that the use appropriate instructional strategies can influence the performances of low achieving students. However, Divers, Asoko, Oldham, Leach, Scott and Mortimer (1994) discovered that learning can be made successful in science classrooms when more emphasise are laid on prior knowledge rather than the students' cognitive level.

Constructivist learning is based on cognitive theory of learning which holds that learning takes place as a result of intuition that is, the individual intuitively bring a number of events together to serve a purpose in solving a particular problem at a particular time. Problem based learning is an example of constructivist learning strategy which poses significant contextualized real world situations and providing resources, guidance, and instruction to learning as they develop content knowledge and problem solving skills(Yager,1991). Maloney (1994) defined problem based learning as a strategy that consists of carefully selected and designed problems that demand from the learner acquisition of critical knowledge, problem solving proficiency, self-directed learning strategies, and team participation skills. It reduces teacher's instruction where learners are seen as active listeners and passively involved in classroom activities as in the case of conventional method.

Problem based learning has been used effectively in medical schools which have been found to be effective and enhances retention and studies have also shown that problem based learning leads to an understanding of physics (Maloney, 1994; Hobden, 1999; Gaigher, 2004). The researcher is hereby optimistic that if PBL can be used appropriately in physics classroom it will bridge the existing gaps and further improve the students achievement most especially students with low ability level.

Statement of The Problem

For more than a decade now, the different instructional strategies employed in teaching physics have not improved students' achievement in the subject to an appreciable extent. It is therefore, pertinent at this critical time when high premium is placed on science and technology as the bedrock of national development and advancement to search for an approach for teaching physics in order to enhance maximum outcome.

Purpose of Study

The study is design to achieve the following objectives:

(1) To investigate the extent to which the use of problem based learning technique will enhance the academic achievements of students with low ability level and those taught with conventional method in physics.

(2) To compare the academic achievements of physics students taught with problem based learning technique and those taught with conventional learning method.

(3) To compare the academic achievements of male and female physics students taught with problem based learning technique and those taught with conventional learning method.

Hypotheses

(1) There is no significant difference between academic achievements of physics students taught with problem based learning technique and those taught with conventional method.

(2) There is no significant difference between the academic achievements of low ability physics students taught with problem based learning technique and those taught with conventional method.

(3) There is no significant difference between the academic achievements of male and female low ability physics students taught with problem-based learning technique.

Method

The research design adopted for this study was pre-test-post-test control design.

Population

The population of the study comprised of all the senior secondary school two (SSII) physics students in all the 40 co-educational secondary schools in Taraba state Nigeria. The population was 320 senior secondary school two (SS II) physics students.

Sample and Sampling Technique

105 physics students were used for the study. This comprised of 55 male and 50 female students. A purposive sampling technique was used to select schools from the target population. The criteria used for the selection includes:

(1)Schools that have at least one graduate physics teacher with at least two years of teaching experience.

(2) Schools that have well equipped and functional physics laboratory.

(3) Schools that are currently presenting candidates for senior secondary school certificate examination (SSCE).

Five (5) schools met the criteria. From the schools that met the criteria, two schools were randomly chosen and they were randomly assigned to problem-based learning technique and conventional learning method. 51students were used for the study in problem-based learning technique while 54 were used for conventional learning method respectively in their intact classes.

Instrumentation and Validation

The instrument used to measure student achievement test and ability test were developed by the researcher and were validated by two physics experts and educational evaluator. The instruments used for the study are Physics Achievement Test (PAT) and Physics Ability Level Test (PALT). Each instrument was a 50- multiple choice questions constructed on the concept of waves. The instruments were trial tested to establish reliability. One of the schools that met the criteria but not used for the main study was used for the trial testing study. Kuder-Richardson formula 21 (K-R 21) was used to calculate the reliability coefficient of the two instrument and the coefficient of internal consistency for PAT and PAL was 0.72 and 0.76 respectively.

Research Procedure

The Physics Achievement Test (PAT) was initially administered to the groups as pre-test and the scores were used for comparability. The Physics Ability Level Test (PALT) was administered to the treatment groups and the results were used to classify students into different ability group that is, high ability, average ability and low ability levels. Students of different ability levels were placed together in small groups with special focus on low ability students which comprises of four students per group. Physics teachers in each school were used as research assistants to each of the treatment groups in other to ensure teachers' quality. They were given detailed instructions with lesson packages on how to teach each group on the concept of waves. Each group were graded at the end of the lesson based on their performances. The two groups were taught the concept of waves using the same content outline and the teaching of the concept lasted in each group for the period of four weeks. After the treatment, post-test was administered to the two groups and the scores were subjected to statistical analysis.

Data Analysis

Analysis was carried out using T- test. The three hypotheses generated formulated at $p<0.05$ alpha levels.

Results

Hypotheses I

There is no significant difference between academic achievements of physics students taught with problem based learning technique and those taught with conventional method. The result is presented in Table 1.

Table 1. Analysis of significant difference between academic achievements of physics students taught with PBL and Conventional method.

Learning Technique	N		S.D	DF	t-cal	t-critical	Decision at p<0.05
Problem based	51	42.68	3.48	103	8.99	1.96	*
Conventional	54	36.42	3.64				

*= significant at $p<0.05$ alpha level

The result of the analysis in Table 1 showed that the calculated t-value of 8.99 was greater than the critical t-value of 1.96. Therefore, the null hypothesis which stated that there is no significant difference between academic achievements of physics students taught with problem based learning technique and those taught with conventional method was rejected. This implies that there is a significant difference between the academic achievements of physics students taught with problem based learning technique and those taught with conventional method.

Hypotheses II

There is no significant difference between the academic achievements of low ability physics students taught with problem based learning technique and those taught with conventional method. The result is represented in Table 2.

Table 2. Analysis of significant difference between the achievements of low ability students taught with PBL and conventional method.

Learning technique	N		S.D	DF	t-cal	t-critical	Decision at P<0.05
Problem based	31	32.84	3.25	64	4.93	1.96	*
Conventional	35	28.75	3.46				

*= Significant at p<0.05 alpha level

The result of the analysis in Table 2 showed that the calculated t-value of 4.93was greater than the critical t-value of 1.96. Therefore, the null hypothesis which stated that there is no significant difference between the academic achievements of low ability physics students taught with problem based learning technique and those taught with conventional method was rejected. This shows that there is a significant different between the academic achievements of low ability physics students taught with problem based learning technique and those taught with conventional method.

Hypotheses III

There is no significant difference between the academic performance of male and female low ability physics students taught with problem based learning technique. The result in Table 3

Table 3. Analysis of significant difference between the achievements of low ability students taught with PBL.

Gender	N		SD	DF	t-cal.	t-critical	Decision at P<0.05
Boys	14	33.50	3.20				
				29	1.13	2.05	NS
Girls	17	32.18	3.30				

NS= Not significant at p<0.05 alpha level

The result of the analysis in Table 3 showed that the calculated t-value of 1.13 was less than the critical t-value of 2.05. Therefore, the null hypothesis which stated that there is no significant difference between the academic achievements of low ability physics students taught with problem based learning technique was not rejected. This indicates that there is no significant difference between the academic achievements of physics students taught with problem based learning technique.

Discussion

The analysis in table 1 showed that the physics students taught with problem-based learning technique performed better than those taught with conventional method. The result was in line with Agbayewa, (1996), Adesoji, (1997), Iroegbu, (1998) they found out that students that are exposed to problem-based learning strategy performed significantly better than those exposed to conventional method. It promotes empowerment and self-reliance and significantly elevates the self-confidence of the learner which cannot be obtainable by using conventional method.

It is glaring from the analysis on Table 2 that there was a significant difference in the academic achievement of low ability physics students taught with problem-based technique and those taught with conventional method. The results in agreement with Carin, (1993), Adesoji, (1997) that reported that students performed well in solving problems when exposed

to problem solving technique and which has been shown to enhance students' performance in science related subjects.

Table 3 Analysis showed that there is no significant difference in the academic achievement of male and female physics students taught with problem-based learning technique. The results in agreement with Akinbobola (2004) that found out that gender have no significant effect on the performance of physics students. Also, (Taber, 1991), Iroegbu, (1998), which found out that gender, has no effect on the academic achievement of physics' students taught problem based learning.

Conclusion

Based on the findings of this research, the following conclusions were made:

1. Problem-based learning technique is more effective in teaching and learning of physics and science subjects in particular than the conventional method.

2. problem-based learning technique exposed to students more to realities of life and tend to work as scientist and acquire knowledge by themselves which the teacher only correct their miss conceptions.

3. The performances of male and female students are not significantly better than their female counterparts when they are taught with problem-based learning technique.

4. problem-based removes teacher as a dictator and sole owner of knowledge which render students passive. Students are actively involved in problem-based learning technique which is not so in conventional learning method.

5. Problem-based equalizes interactions between male and female physics students.

6. Problem based learning technique improves the academic achievement of low ability physics students in which when adopted in our schools it will improve the performance of students in public exams like WAEC, NECO which is a great concern to educators.

Recommendations

1. Physics teachers should adopt the use of problem-based learning technique at all levels of learning.

2. Classroom and physics laboratory should be arranged in such away to give room for effective interaction among students.

3. problem-based learning technique should be adopted in schools, these allows students interactions and encourages higher order thinking level.

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