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Impact Of Problem-Based Learning on Interest and Achievement in Mechanics Among Senior Secondary Physics Students in FCT, Abuja

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Abstract- ***This work focused on the impact of Problem Based Learning on students' interest and achievement in mechanics in Federal Capital Territory, Abuja. Two research questions were raised, and two null hypotheses were formulated with the adoption of the Quasi-experimental pretest posttest research design. The study was carried out in two purposively selected coeducational secondary schools in the Federal Capital Territory, Abuja. A sample size of 150 physics students from two randomly selected intact classes in the sample was used. The instruments for data collection were the Physics Achievement Test (PAT) and the Physics Interest Questionnaire (PIQ) with the reliability coefficient of 0.72 and 0.70 respectively. Descriptive statistics were used to answer the research questions while the Analysis of Covariance (ANCOVA) and the Mann Whitney U test were used to test the null hypotheses. The results showed that there was significant difference between the mean achievement scores of experimental group and control group. There was also a significant difference between the mean interest scores of the experimental group and the control group. The research concluded that using Problem-based Learning strategy makes students learn better about Physics and it makes them active in the classroom to achieve stated objectives due to its learner centered attribute. Therefore, the strategy has positive impact on students' achievement as well as their interest in mechanics.***

Index Terms- ***Active Learning, Problem based learning, Mechanics, Achievement, Interest, Physics***

I. INTRODUCTION

Physics is the study of matter and energy and the relationship between them. Ibibo and Francis (2017) defined Physics as the study of systemized knowledge produced by careful observation, measurement and experimentation with the motive of establishing basic physical laws and explanation of basic physical phenomenon. As a science, the primary objective of Physics is to be used as a tool for understanding the environment and how it functions thereby creating avenue for the excavation of further knowledge. In this process, the foundation of technology is laid through which the rewards of science are harnessed. Thus, Berkeley (2020) stipulates that knowledge allows us to develop new technologies, solve practical problems and make informed decisions – both individually and collectively.

Harnessing the rewards of Physics brings about improvement in the quality of life for the individuals and an upgrade in the national economy and development. Mahboob (2017) notes that innovation or technological progress is the only determinant of economic progress. In the United Nations Millenium summit held in 2000, it was recognized that Physics and science in general play a crucial role in attaining sustainable development (Forestier & Kim, 2020). Hence, countries strive in whatever way they can to record some progress in Physics. Nigeria has not been left out in the race. Starting from the very beginning; convention of the 1969 curriculum conference to eventual emergence of the first National Policy on Education in 1977 by an indigenous government, Science of which Physics is a core aspect has always been emphasized.

In spite of the promising rewards that Physics has for both individuals and Nigeria as a nation, and the priority accorded it at the highest policy level, student's interest and achievement has consistently remained poor. This implies that the level of academic success in Physics required translating the learned content into material benefits for individuals and the country at large has not been achieved. Of particular concern is the fact that students' interest in

the subject is consistently on the decline through the years.

Interest is a powerful motivational process that energizes learning, guides academic and career trajectories, and is essential to academic success. Interest is both a psychological state of attention towards a particular object or topic, and an enduring predisposition to reengage over time (Singha, 2022). Ukor and Abdulbajar (2019) defined interest as the feeling that stimulates an individual to activity without any external influence. Every activity on earth, learning inclusive, must have objectives in order to enjoy the patronage of human attention. Learning in itself is an interesting activity where there is proper planning and meaningful engagement in and out of the classroom. Hence, Wild (2022) posit that students who discover academic interests in High Schools and Colleges are better prepared for a satisfying career, explaining further that interest is a powerful motivational process that energizes learning and guides academic and career trajectories.

Academic achievement on the other hand refers to students' success in meeting short or long-term goals in education. According to Steinmayr, Meibner, Weidinger and Wirthwein (2014), academic achievement represents performance outcomes that indicate the extent to which a person has accomplished specific goals that were the focus of activities in instructional environments, specifically in school, college, and university. This is reflected by the extent to which skill or knowledge has been imparted in the learner. Academic achievement is knowledge acquired and skills developed in school subjects, which is generally indicated by marks obtained in tests in an annual examination (Nwakpa & Okoli 2023). Academic achievement is a reliable measure of individuals' level of knowledge and skills acquisition in higher education. It is a complex human activity and one not easy to conceptualize through a simple model (Sakız, Ozdaş, Goksu, & Ekinci, (2021).

Learning Physics requires students' involvement, and the method of teaching chosen by the teacher should have this characteristic. Mechanics for example is an aspect of Physics concerned with the motion of bodies under the action of forces. It also considers the action of these forces on bodies at rest. Concepts such as motion can easily be simulated in a classroom environment because it is what every physical body engages in. Traditionally, teaching has to do with the passing of knowledge by telling the learners what they might not know, and it involves learning materials like a board, textbooks, and visual aids. Mallillin and Mallillin (2024) noted that this method has been evaluated as poor and inappropriate based on the view of contemporary educational requirements. Ezike (2018) posits that it encourages surface rather than deep learning experience. It is of importance to point out that teaching has long shifted from conventional or traditional approaches. Approaches like the lecture method have been considered ineffective because they encourage the rote factor and ultimately make learning passive. Approaches that encourage active participation of learners have at the moment taken the center stage. These approaches include the Brain Based Learning, Computer Aided Instruction, Context Based learning, Simulation Games, and the Problem Based Learning (Gleason, 2018).

In brief, Problem Based Learning is a pedagogical approach that enables students to learn while engaging actively with meaningful problems. Students are given the opportunities to problem-solve in a collective setting, create mental models for learning, and form self-directed learning habits through practice and reflection (Yew & Goh, 2016). Research has revealed that individuals who have very little familiarity with science concepts can learn new ideas using the PBL structure, and that the same approach can also help experienced science learners with a high degree of prior knowledge refine their understanding and learn to better explain the mechanisms for scientific phenomena (Chinonyerem and Njoku, 2024).

Physics as a subject is the bedrock for technological advancement, industrial development and economic progress, and it requires proper delivery in the classroom to eliminate deficiencies that have led to underachievement for many years. According to Mbia and Nsungo (2019), the knowledge of Physics forms the basis for technological advancement of any nation. This is why the subject needs to be taught well in order to enable students to develop interest in

it. Yet, it has been observed over the years that there is persistent underachievement in the subject. Refer to Appendix (IX) as reported by the National Examinations Council, (NECO).

Under-achievement of students in Physics has been a concern for the Nigerian educational stakeholders for a long time, and research has been on-going. Hence, Oladele (2021) categorized the factors responsible these poor results into three; student factors, environmental factors and teacher factors. They went further to explain that student factors include lack of interest and poor study habits while teacher factors include laziness and poor teaching methods. Hence, this study was set to investigate the effect of problem based learning strategy on students' interest and achievement in Mechanics in Federal Capital Territory, Abuja.

II. STATEMENT OF THE PROBLEM

Physics as a subject is the bedrock for technological advancement, industrial development and economic progress, and it requires proper delivery in the classroom to eliminate deficiencies that have led to underachievement for many years. According to Mbia and Nsungo (2019), the knowledge of Physics forms the basis for technological advancement of any nation. This is why the subject needs to be taught well in order to enable students to develop interest in it. Yet, it has been observed over the years that there is persistent underachievement in the subject as reported by the National examination Council (NECO).

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Traditionally, teaching has to do with the passing of knowledge by telling the learners what they might not know, and it involves learning materials like a board, textbooks, and visual aids (Khan, Majoka, Khurshid, and Manzoor, 2017). This approach is being discouraged in contemporary times as it encourages rote learning and memorization, and ultimately makes learning passive. Active learning is now being encouraged. Active learning is not a teaching method per say but a generic description of all teaching methods in which students participation is high, among which is Problem Based Learning Strategy.

Problem Based Learning is a pedagogical approach that enables students to learn while engaging actively with meaningful problems. Students are given the opportunity to problem-solve in a collective setting (Yew & Goh, 2016). Problem-based learning (PBL) is a student-centered pedagogy in which students learn about a subject through the experience of solving an open-ended problem found in trigger material. This leads to the development of interest in the subject matter and will invariably lead to a higher achievement in the subject. Hence, the problem of this study was to investigate the effect of problem based learning strategy on students' interest and achievement in Mechanics in Federal Capital Territory, Abuja.

Objective of the Study

The study investigated the effects of Problem Based Learning on SS2 students Interest and Achievement in Mechanics in Federal Capital Territory, Abuja. The specific objectives of the study were to:

i. find out the difference between the mean interest scores of students taught Mechanics using Problem-Based Learning Strategy and students taught Mechanics using the conventional method.
ii. determine the difference between the mean achievement scores of students taught Mechanics using Problem-Based Learning Strategy and students taught Mechanics using the conventional method;

Research Questions

The following research questions were used to guide the study

i. What is the difference between the mean interest score of students taught Mechanics using Problem Based Learning Strategy and that of their counterparts taught using conventional method?
ii. What is the difference between the mean achievement score of students taught Mechanics using the Problem Based Learning Strategy and that of their counterparts taught using the conventional method?

Hypothesis

Based on the problem, the following null hypotheses were formulated and tested at 0.05 level of significance.

HO_1: There is no significant difference between the mean interest score of students taught mechanics using the Problem Based Learning Strategy and that of their counterparts taught using the conventional method.

HO_2: There is no significant difference between the mean achievement score of students taught mechanics using the Problem Based Learning Strategy and that of their counterparts taught using the conventional method.

III. METHODOLOGY

The study adopted the Quasi-Experimental pretest-post research design which intended to compare outcomes for groups: those (experimental) who received instruction with the problem-based learning strategy and those (control) that were taught using the conventional method of teaching. The following are the variables: Problem-based learning (Independent), Conventional teaching method (Independent), Achievement in Mechanics (dependent) and Interest in Physics (dependent).

The target population of this study comprised of all the SS 2 Physics students across the 88 senior secondary schools within the six (6) Area Councils of the Federal Capital Territory (FCT), Abuja. The total population is 4,262 students, categorized according to their gender, male 2,316 and female 1,946 in FCT, Abuja (Educational Resource Centre, 2024).

The sampling technique adopted was random sampling which made it possible for all schools to have an equal chance of being selected according to Lorh (2019). At the next stage of sampling, simple random sampling method was used in selecting an intact class each from the two sampled schools. Finally, the two classes selected were assigned as experimental and control group by the toss of a coin. The research instruments used for the collection of data in this research were the Physics Achievement Test (PAT), Physics Interest Questionnaire (PIS), and Lesson plan. Each of the instruments is described as follows: The Physics Achievement Test which was used for this study consisted of twenty (20) questions of the multiple-choice nature with four (5) options lettered A-E. All the questions were of equal weight of a mark each totaling 20 marks. The PAT was constructed based on the objectives of Senior Secondary School Physics learning curriculum i.e Knowledge, Comprehension, Analysis, Application, Synthesis and Evaluation according to Blooms Taxonomy of Learning. Standardized questions already framed in the field of Mechanics were reviewed and selected from question banks of the National Examination Council (NECO).

The Physics Interest Scale (PIS) was used for scaling students' interest in Physics before and after treatment. The scale was adapted from (Maison, Darmaji, Astalini, Kurniawan, Sumaryanti, & Perdana, 2020). It comprised two parts, A and B. Part A covered the students response to personal questions as gender, while part B bothered on students interest towards learning physics. It had four point Likert type scale i.e Strongly Agree (SA), Agree (A), Disagree (D), Strongly Disagree (SD) with points assigned as follows: SA =4, A=3, D=2, and SD =1 for positive statements while the points were reversed for negative statements.

The researcher prepared two sets of Lesson Plans for the study. One for the Experimental group and the other for the Control group on the topics that were covered. Each set of plans contained ten lessons to be taught over a period of ten (10) weeks. One of the sets was made up of conventional lesson plans while the other incorporated mathematics skills as part of learning objectives (See Appendix VI and VII). The experimental group was taught selected topics in

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mechanics using the PBL strategy which will involve questions that were part of the pre-test examination before a final post-test will be carried out. The control group was also taught same selected topics in mechanics using the conventional method after the pretest has been administered on them.

IV. RESULT

The data collected were presented and analyzed using descriptive statistics (Mean, standard deviation), Analysis of Covariance (ANCOVA), and the Mann Whitney U- test.

Research Question One

What is the difference between the mean interest score of students taught Mechanics using Problem Based Learning Strategy and that of their counterparts taught using conventional method?

Table 1: Mean and Standard Deviation of SS II Students' Interest in Physics for Experimental and Control Groups

Group	N	Mean Scores Pre-test $\bar{x}$	Mean Scores Post-test $\bar{x}$	Standard Deviation SD	Mean Gain $\bar{x}$
Experimental	60	52.90	66.73	6.92	13.83
Control	90	51.23	52.13	4.66	0.83
Mean Difference		1.67	14.60		**13.00**
Total		**150**			

The result presented on Table 3 shows that students who were taught Physics with Problem-based learning strategy had a pre-test interest mean score of 52.90 and post-test mean score of 66.73 with a standard deviation of 6.92. On the other hand, the student that were taught Physics with conventional teaching method had a pre-test interest mean score of 51.23 and post-test interest mean score of 52.13 with a Standard Deviation of 4.66. An examination of the table revealed that the mean gain in interest of students taught Physics using Problem-based learning strategy was 13.83 while that of students who were taught using conventional method was 0.83 However, the overall mean difference between the groups was 13.00 which favored students in experimental group which indicates that the interest mean scores of SS II students taught Mechanics using Problem-based learning strategy method was higher than their counterpart taught using lecture method.

Research Question Two

What is the difference in the mean achievement scores of students taught Mechanics using the Problem Based Learning Strategy and those taught using the conventional method?

Table 2: Mean and Standard Deviation of SS II Students' Achievement in Physics for Experimental and Control Groups

Group	N	Mean Scores Pre-test $\bar{x}$	Mean Scores Post-test $\bar{x}$	Standard Deviation SD	Mean Gain $\bar{x}$
Experimental	60	13.98	17.51	3.87	3.53
Control	90	13.72	14.54	3.03	0.82
Mean Difference		0.26	2.97		2.71

The result presented on Table 4 shows that students' who were taught Physics with Problem-based learning strategy had pre-test achievement mean score of 13.98, post-test mean score of 17.51, Standard Deviation of 3.87 and achievement mean gain score of 3.53. On the other hand, the students that were taught Physics with conventional method had pre-test mean score of 13.72, post-test achievement mean score of 14.54, Standard Deviation of 3.03, and a mean gain of 0.82. However, the overall mean difference between the groups was 2.71. Hence, the difference in the mean achievement scores of students taught Mechanics using the Problem Based Learning Strategy and those taught using the conventional method was 2.71.

Hypothesis One

H_{O1}: There is no significant difference in the mean interest score of students taught Mechanics using Problem-Based Learning Strategy and those taught using the conventional method.

To test for the hypothesis, a Mann Whitney U Test was used and result presented in table 8.

Table 3: Mann-Whitney U-Test Showing Difference between the Interest Mean Scores of experimental and control groups

Group	N	U-Statistic	z-Score	p- Value	Effect Size (r)	Media Rank
Experimental	60	4759.5	7.90	0.001	0.65	~65.4
Control	90					~40.2

Significant at P-value >less that 0.05

The result on the table 5 shows a P-value of 0.001 with a difference in the median rank of 25.2 with an effect size of 0.65. It also shows a Z-Score of 7.90. Since the P-value of 0.001 is less than 0.05 level of significance, this indicates that there is significant difference in the Physics interest mean scores of SS II students taught Physics with Problem-based learning strategy and those of their counterparts taught without the strategy. Therefore, the first null hypothesis was rejected. In other words, respondents from both groups differed significantly in their interest mean scores which favored the experimental group who were taught using Problem-based learning strategy teaching method.

Hypotheses Two

$H0_2$: There is no significant difference in the mean achievement scores of students taught mechanics using the Problem Based Learning Strategy and those taught using the conventional method.

Table 4: ANCOVA Showing Difference between the Achievement
Mean Scores of the Experimental and Control Groups

Source	Sum of Squares	df	F	p-value
Corrected Model	257.16	4	-	-
Group	127.67	1	9.96	0.00195
Pretest	91.66	1	7.15	0.00837
Intercept	1658.92	1	128.36	< 0.00001
Residual (Error)	1859.49	145		
Corrected Total	2116.65	149		

*Significant at P-value > less than 0.05; and df = 148

Table 6 shows that the sum of squares for the groups was 127.67 with an F-statistics of 9.96 suggesting a very strong evidence against the null hypothesis. It also shows a P-value of 0.00195. Therefore, Since the P-value of 0.00195 is less than 0.05 level of significance, the second null hypothesis was rejected which indicates that there was significant difference in the achievement mean scores of SS II students taught Physics with Problem-based learning strategy and those taught with conventional teaching method. In other words, the null hypothesis of no significant difference in the achievement in mean scores of students taught Physics with Problem-based learning strategy and those taught with conventional teaching method was rejected. This means that respondents from both groups differed significantly in their achievement mean scores which favored the experimental group who were taught using Problem-based learning strategy teaching method.

V. DISCUSSION

The purpose of this study was to investigate the effect of Problem-Based Learning Strategy on Students Interest and Achievement in Mechanics in Federal Capital Territory, Abuja. Two research questions and two hypotheses were raised which guided the study.

The data presented in table 1 provided answer to research question 1, and from the result, the interest mean score of students taught Mechanics using Problem-based learning strategy was higher than the interest mean score of those taught with conventional method. The result from the Mann-Whitney U test as reported in table 3 also shows that there was a significant difference between the mean scores in interest of students taught Mechanics using Problem-based learning strategy and those taught using conventional method. This is due to the fact that this approach to learning is highly effective in promoting students' engagement and motivation, as well as in improving students' critical thinking skills and ability to apply what they have learned to real-world situations. These findings are consistent with the findings of Aidoo (2016) who found that there was a significant difference between the interest mean scores of students taught Computer Studies using Problem-Based Learning Strategy and those taught using conventional method. The findings are also consistent with Nwosu, Ndanwu, and Nwako (2020) who found that Computer Aided Instruction method of teaching enhanced students' interest in electronic libraries in tertiary institutions. However, this finding is in disagreement with Argaw, Ayalew, and Kuma

(2017) whose statistical result showed that there was no significant difference in students' motivation to learn Physics between the experimental and control groups. In their study, the problem-solving skills of both groups increased considerably but their motivation remained stagnant, and stagnant motivation may indicate stagnant interest. This finding is in consonance with Mokuolu and Ojo (2023) results which showed that in the problem-based learning strategy, the students showed more interest and they retained the concepts for a long period of time as compared to the traditional lecture method. The result is also in line with the findings of Cheptirim, Maina, and Ngeno (2023) who in their study found that interest mean score of experimental group was higher than that scored by the control group. The reason for the difference could be as a result that problem-based learning strategy provides active participation of students which thus arouses their interest and consequently boost their interest towards science. It means the method help to boost students' interest towards Physics.

The data presented in table 2 provided answer to research question 2, and from the result, the achievement mean score of students taught Mechanics using Problem-based learning strategy was higher than the achievement mean score of those taught with conventional method. The overall mean difference between the groups favored students taught Mechanics with Problem-based learning strategy. Also, the result of ANCOVA as reported in table 4 showed that there was a significant difference in the achievement mean scores of students taught Physics with Problem-based learning strategy and those taught with conventional teaching method. As a result, the second null hypothesis was rejected. In other words, students from both groups differed significantly in their achievement mean scores which favored the experimental group. This suggests that Problem-based learning strategy is a good instructional method relative to lecture method, and that it can be used to improve students' achievement in Physics. This finding is in affirmation of the result of David, Anyagh and Adeniran (2021) who reported that experimental group taught with PBLS performed better than the control group in the study which investigated the effect of Problem-Based Learning strategy on Upper Basic Education Students Interest, Achievement and Cognitive Load in Basic Science in Katsina-Ala Local Government Area of Beneue State. They found that students taught using PBLS recorded higher interest, achievement and expanded their low cognitive load compared to their counterparts taught using lecture method. The results can be validly compared since the same treatment was given under similar learning conditions although different subjects. Jack (2021) findings also showed that there was significant effect of treatment on students' achievement in Chemistry using PBL and LBL in favour of PBL. The findings also revealed that there is a significant difference in performance in Chemistry of students taught using PBL and LBL; in favour of PBL.

Similarly, the results of Bedemo (2022) indicated that students taught using Problem-based learning strategy performed significantly better than their counterparts taught using the conventional method of instruction. Students taught using Problem-based learning strategy performed better than the control group in retention test. The similarities in the findings could be attributed to the effectiveness power of the teaching method over lecture method, as students are able to understand and apply the concepts and principles of physics to real-world problems. This approach to learning is highly effective in promoting student engagement and motivation, as well as in improving students' critical thinking skills and ability to apply what they have learned to real-world situations. However, the result negates the findings of Owusu, Monney, Appiah and Wilmot (2010) who in their studies submitted that the performance of students' taught by the conventional approach performed better in the post-test examination.

VI. CONCLUSION

Teaching is effective when the teacher is well informed about the subject matter and the appropriate method for initiating and perfecting learning. In general, findings substantiated the effect of Problem-based learning strategy and conventional teaching method on students' achievement and interest in Physics. The positive impact in the PIS test and PAT test results demonstrate that by using PBLS teaching method which is learners' center and activity

oriented, the students' achievement and interest in Physics was increased. The researcher therefore concluded that the use of Problem-based learning strategy method for teaching is effective and successful in the improvement of students' achievement in Physics, and as well boost their interest than those taught using the conventional teaching, students learn better about Physics, carried out their responsibilities and make effort to achieve a stated objective due to its learner centered attribute.

Above all, the experimental group performed better than the control group which revealed that the use of PBLS has a remarkably significant effect on academic achievement and interest in secondary school II Physics students' in FCT Abuja.

VII. RECOMMENDATIONS

The following recommendations were made based on the findings:

1. Physics teachers should use the Problem Based Learning in the classroom as it stimulates students' interest in the subject.
2. Ministry of Education should provide and other stake holders should provide Learning aids that suit the implementation of PBLS for higher achievement in Physics.
3. In the course of training, relevant institutions should train teachers on the use of Problem Based Learning Strategy so as to improve effectiveness in the classroom and rouse students' interest towards better achievement.
4. Government agencies such as State Governments, Federal Ministry of Education, and National Commission for Colleges of Education (NCCE) should regularly organize training sessions for in-service teachers on the use of PBLS so as to clear the perceived gender bias in Physics

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