# EDUCATION:

## A Communication Channel For National Development

EDUCATION:

*A Book of Readings in Honour of*

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**1. LANGUAGE, RELIGIOUS, CULTURAL AND MORAL EDUCATION**



**2. TEACHERS AND RELATED ISSUES**



**3. HIGHER EDUCATION AND EDUCATION QUALITY ISSUES**

- Collaborative efforts between the school administrators and staff of federal science equipment centres in the training and re-training of teacher is desirable.
- In-service training and workshops on improvisation at regular interval should be organized for teachers on design and maintenance of essential materials for teaching.
- Instructional manual on improvisation of major materials to teachers should be produced to serve as guide to teachers.
- Collaborations with introductory technology teachers will help to sharpen teachers' manipulative skills and dexterity in the handling of tools required in improvisation.
- Field-trip to federal science equipment centre will give the needed exposure to teachers.

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CHAPTER 27

# PROBLEM SOLVING: AN EFFECTIVE STRATEGY IN DEVELOPING STUDENTS' SKILLS IN PHYSICS EDUCATION

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**Abstract**

*This study is to determine how the problem solving strategy and lecture method would affect students' achievement in physics. A non-randomised pre-test and post-test quasi-experimental design was adopted. A total of 253 (154boys and 99 girls) senior secondary school II (SSSII) physics students who make the intact classes in the six selected schools form the sample. The instrument used was a Physics Achievement Test (PAT) which was made up of 25-items multiple choice questions and 3-item essay questions. The results show that the experimental group performed significantly better than the control group. This result supports other research efforts which revealed that the problem solving strategy is an effective technique for bringing about meaningful learning in science students.*

**Background to the Study**

Physics is considered as the most problematic area within the realm of science, and it traditionally attracts fewer students than other science areas (Synder, 2006).

Exploratory research has revealed the reason associated with students' attitudes towards physics as a subject and methods of teaching (Craker, 2006; Normah and Salleh, 2006; Hough and Piper, 1989). Normah and Salleh (2006) indicated that students' attitude and interests could play a substantial role among students studying science. Several studies, such as Ajzen and Fishbein (2000) and Wilson, et al. (2000) reported that students' positive attitudes towards science highly correlate with their achievement in science.

In Nigeria, while the approach to teaching is the lecture or convetional method (Balogun, 1995), researchers (e.g. Uhumuaubi and Eromosele, 2006, Ogunleye, 1993) have shown that this traditional communication mode of teaching and learning science are deficient in training the requisite number and quality students with commitment for science and technology. Therefore, researchers such as Danmole (2005), Onwioduokit (2000) Owolabi (2000), Nworgu (2002) e.t.c in science education have continued to evolve new ways of teaching science for meaningful learning on one hand and its application to real life experience on the other.

Research has shown that conventional teaching has a negative effect on most students' learning than compared to teaching using meta-cognitive strategies e.g problem solving and physics Education goals cannot be achieved by conventional science teaching (Rivard and Straw, 2000).

When students have knowledge about problem solving strategies at the stage of problem translation, it has been proven that students will have the skill to Interprete physics problems sentence by sentence, using knowledge and the problem solving method. Students are able to Interprete and understand the terms, facts and physical concepts based on their acquired knowledge. At the stage of problem integration, students are able to combine the different pieces of interpreted information into a coherent structure in order to plan a solution. (Gonen and Basaran, 2008; Redish, 2005).

Students do not know how to choose methods most suited for solving each problem and a majority of students learned knowledge strategy by conventional teaching try to memorize physical rules and definitions without fully understanding the underlying concepts. (Gonen and Basaran, 2008; Reid and Skryabina, 2002).

Teachers can enhance students' problem solving skills by providing appropriate exercises and encouraging positive interaction among students during the learning process. They should also use an appropriate problem solving method to teach and offer an opportunity for their students to explore physics by preparing fun learning activities and by encouraging them to think critically and creatively.

Physics instructors and teachers generally accept that problem solving leads to an understanding of physics. However, sources in calculating correct numerical answers do not necessarily imply a corresponding level of conceptual understanding (Mintezas, 2001).

Problem solving, in general, involves dealing with new and unfamiliar tasks when the relevant solution methods (even if partly mastered) are known (Schonefeld, 2002).

Conceptual understanding and problem-solving are inseparable companions.

Understanding of concepts in physics has a high correlation with students' problem-solving ability (Ogunleye, 1993).

**Statement of the Problem**

The teaching of physics for understanding, comprehension and assimilation has been a source of serious concern to Science Educators in recent time. It has been observed that the way students are taught plays a crucial role in determining to what extent they have learnt. This study seeks to investigate the effectiveness of the problem solving strategy over the use of conventional method in teaching physics. This was achieved by comparing students' performance using the two methods.

**Hypothesis**

Specifically, the study attempted to test the following research hypothesis:

1. There will be no significant difference in the achievement of the male and female students exposed to the problem solving strategy.
2. There will be no significant difference in the achievement of male and female students exposed to the lecture method
3. There will be no significant difference in the pre-test achievement of students in the experimental and control groups
4. There will be no significant difference in the post- test achievement of students in the experimental and control groups.

**Methodology**

A quasi-experimental study using a non-randomized control group pre-test and post-test design was used in this study.

The target population involved all Senior Secondary School (SSS II) physics students in Ojo Local Government area of Lagos State.

Two separate intact classes were used, one for the experimental and the other for the control groups. A total number of Five hundred and twenty-seven (527); (347 males and 180 females) senior secondary school (SSII) physics students participated in the study. The students were drawn from six randomly selected co-educational public secondary schools in Ojo Local Government of Lagos State. Students in three (3) of these schools were used as control group (Group A) while the students in the other three (3) schools were used as the experimental group (Group B).





**Instrumentation**

The instrument used was a Physics Achievement Test (PAT) which was made up of 25-items multiple choice questions and 3-item essay questions. The Physics Achievement Test (PAT) were adjudged adequate in scope and content based on the chosen topics by a subject specialist at the university, and two experienced physics teachers at the secondary school level. The content area which the questions covered include: propagation of light, reflection on both plane and curved mirrors, image location in both and curved mirrors, using ray diagrams, application of both lane and curved mirrors, refraction by both plane surfaces and lenses, critical angle, total internal reflection, applications of lenses and deviation in both converging and diverging lenses. The physics questions are justified for this study because they cover the topics specified in the physics subject curriculum for the period of the session when the research was carried out. The questions were randomly drawn from the West African Examination Council past question (WAEC) of 1998 to 2006. Each item in the multiple choice questions had four (4) options labeled A to D with one of the options being the correct one and students were required to choose the correct option. The answer scripts were collected the same day. Using the Kuder Richardson formular 20, the reliability of the test was 0.78

**Data Collection**

After grouping the six schools as Experimental (Group B) and control (Group A), a pretest was administered to the students in order to determine their previous knowledge of the chosen physics concepts. The answer scripts were collected the same day. The pretest questions covered topics such as Propagation of light, reflection on both plane and curved mirrors, image location in both and curved mirrors, using ray diagrams, application of both plane and curved mirrors, refraction by both plane surfaces and lenses, critical angle, total internal reflection, applications of lenses and deviation in both converging and diverging lenses. Treatment was then carried out on both control group (Group A) and experimental group (Group B) in four weeks with each of the instructional period spanning forty minutes. They were taught the topics listed above and for the same period using the lecture method for the control group and the problem solving strategy for the experimental group.

A posttest was administered to the students by the researcher using similar questions to that of pretest. The pretest answer sheets were also collected same day for marking and scoring.

Assistance was provided by the Schools physics teachers in the area of invigilating the pre and post tests but was monitored in order to avoid teachers' influence on students' responses to the tests.

The following steps were adopted in the presentation of the problem solving strategy:

Step I: the teacher wrote the topic on the board

Step II: the teacher introduced the lesson to the students

Step III: students were asked to explain concept being taught in their own words.

Step IV: students were asked to sketch relevant simple (free body diagrams) to back the explanation above under teacher's guidance.

Step V: students were asked to state relevant formula or equations to be used to solve problems on the concept being taught.

Step VI: students were asked to state the known and unknown Quantities

Step VII: students are guided to solve simple problems on the topic under consideration.

**Data Analysis:**

The data collected were analysed statistically using the mean (X), standard deviation (σ), and Analysis of Covariance (ANCOVA) to test the hypothesis formulated in the study.

**Results**

**Table 1: Summary of Scores of those Exposed to Problem Solving and Exposed to Lecture Methods**

| Treatment | | Posttest | Pretest |
|---|---|---|---|
| Experimental | Mean | 36.9379 | 34.8644 |
| | N | 177 | 177 |
| | Std. Deviation | 13.86180 | 13.26109 |
| Control | Mean | 22.7500 | 26.7105 |
| | N | 76 | 76 |
| | Std. Deviation | 5.26403 | 10.57899 |

The comparison of the pretest and posttest means scores of the two groups is presented in table 1 above. The results shows that students exposed to the problem solving technique performed better than their counterpart exposed to lecture method.

**Table 2: Summary of Scores of Male and Female Students**

| Gender | | Posttest | Pretest |
|---|---|---|---|
| Male | Mean | 33.4286 | 32.8701 |
| | N | 154 | 154 |
| | Std. Deviation | 14.66928 | 12.75598 |
| Female | Mean | 31.5051 | 31.7071 |
| | N | 99 | 99 |
| | Std. Deviation | 11.71635 | 13.51587 |

Table 2 shows the comparison of posttest and pretest among the female and males students exposed to problem solving and lecture method. The results however, shows that male students performed better than the female students.

**Table 3: Summary of Analysis of Covariance, ANCOVA on Male and Female Students Exposed to Problem Solving**

| Source | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Main effects (Gender) | 280851.150 | 3 | 93617.050 | 652.295 | 0.000 |
| Treatment | 38876.872 | 2 | 19438.436 | 135.441 | 0.000 |
| Covariates | 16.717 | 1 | 16.717 | 0.116 | 0.733 |





| | | | | | |
|---|---|---|---|---|---|
| (Pretest) | | | | | |
| Residual | 35879.850 | 250 | 143.519 | | |
| Total | 316731.000 | 253 | | | |

**Not significant at P< 0.05**

Table 3 above shows the results of the relationship between the achievement of the male and female students exposed to the problem solving strategy. This implies that the hypotheses which states that there will be no significant difference in the achievement of male and female students exposed to the problem solving strategy is accepted. This means that the performance level of male and female students exposed tp physics concepts using the problems solving strategy is the same.

**Table 4: Summary of Analysis of Covariance, ANCOVA on Male and Female Students Exposed to Lecture Method**

| Source | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Main effects (Gender) | 251416.782 | 2 | 125708.391 | 550.677 | 0.000 |
| Covariates (Posttest) | 33800.647 | 1 | 33800.647 | 148.067 | 0.000 |
| Treatment | 15566.520 | 1 | 15566.520 | 68.191 | 0.000 |
| Residual | 57298.218 | 251 | 228.280 | | |
| Total | 308715.000 | 253 | | | |

**Not significant at P< 0.05**

Table 4 shows the results of the level of influence of the lecture method on the achievement of the male and female students exposed to the lecture method. This implies that there was significant different in the achievement of male and female students exposed to lecture method.

**Table 5: Summary of Analysis of Covariance, ANCOVA of Pretest of Experimental and Control Groups**

| Source | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Main effects | 269370.623 | 2 | 134685.311 | 859.234 | 0.000 |
| Treatment | 269370.623 | 2 | 134685.311 | 859.234 | 0.000 |
| Residual | 39344.377 | 251 | 156.751 | | |
| Total | 308715.000 | 253 | | | |

**Not significant at P< 0.05**

Table 5 shows that the results of the pretest achievement of students in the experimental and control groups revealed that there no was significant difference in the achievement of students exposed to problem solving and those exposed to lecture method.

**Table 6: Summary of Analysis of Covariance, ANCOVA of Posttest of Experimental and Control Groups**

| Source | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Main | 490.731 | 2 | 245.365 | 1039.099 | 0.000 |

| | | | | | |
|---|---|---|---|---|---|
| effects | | | | | |
| Treatment | 490.731 | 2 | 245.365 | 1039.099 | 0.000 |
| Residual | 59.269 | 251 | .236 | | |
| Total | 550.000 | 253 | | | |

**Not significant at P< 0.05**

Table 6 shows the results of the post-test achievement of students in the experimental and control groups, this implies that was no significant difference in the achievement of students exposed to problem solving and those exposed to lecture method.

**Discussion and Conclusion**

This study examined the effectiveness of the problem solving teaching strategy in enhancing students' achievement in physics concepts and improving their conceptual understanding. Four hypotheses were formulated and tested for the purpose of this study. Results from data collected and analyzed stastically revealed that gender had no influence on students' achievement in physics whether exposed to the problem solving strategy or lecture method. Also established in this study is that there exists no significant difference between the pretest achievement of both experimental and control groups. However, results obtained after treatment showed that there was significant difference between the achievement of the experimental groups (students exposed to the problem solving strategy and the control groups (students exposed to lecture method). The experimental group performed better than the control group. This finding is supported by Tenenbaum (2004) who asserted that the problem solving instructional strategy involves students fully in the learning process, has a profound influence on students', aid retention of physics concepts and often it lead to a higher level of achievement of students in physics

Eisenhart (2002) revealed in his study that the utilization of the lecture method (conventional method) in teaching physics concept does not promote desired students' outcome.

**Recommendations**

Based on the results of the study, the following recommendations were made:

- The lecture method as the study revealed, should be used only sparingly where it can not be avoided
- Seminars /Workshops should be organized for physics teachers to expose them with the modern teaching strategies.
- Text books authors should adopt the problem solving strategy in presenting information in their books.
- Education authority at the secondary school level may need to attach a condition of attending and presenting papers at conferences and writing of research papers by secondary school teachers to the promotion of teachers
- Physics teachers should have a mastery of the subject matter and knowledge of accepted scientific view in order to bring about conceptual change.

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