Students' Acquisition of Scientific Skills during Physics Practical Sessions at Saint John's Secondary School, Sekondi, Ghana

Emmanuel Atta Williams

Department of Electrical/Electronics Engineering, Takoradi Polytechnic, Ghana

Abstract- Students of Saint John's Secondary School, Sekondi-Ghana were made to acquire scientific skills in physics during the practical sessions. The treatment was investigated using a randomized pretest –protest experimental design. The performance of thirty (30) students who constituted the experimental group was compared with other thirty (30) students who constituted the control group. Both groups offered Biology with Physics and Chemistry as their electives. The homogeneity in the entry behaviors of the two groups was determined using the two-tailed F-test analysis of variance at 5 % level of significance. Similarly, the t-test analysis of means was invoked for the post-test. The two-tailed t-test performance for 58 degrees of freedom gave a critical value of 2.00 at the 2.5 % probability level. This value was then compared with calculated t-value of 3.17 and it was found that the treatment was effective. The research therefore recommended the approach for the use by teachers to help students to acquire some scientific skills in physics and science in general.

Index Terms- Physics, Practical, Acquisition, Scientific, Skills, Teaching methods

I. INTRODUCTION

Science is the aspect of education in this modern age where most of the technologies are developed. In view of this, most countries are encouraging their citizens to put more interest in science. The professionals such as teachers, technicians, engineers, medical officers, etc all over the world use the practical aspect of science to achieve their goals [1].

There is a relationship of physics to the other sciences- the methods and results of physics have wide applications to the other sciences particularly Chemistry, Biology, Geology, Psychology and Medicine. The development of physics has played an important part in the progress of the other sciences but it must not be assumed that this has been entirely a one-sided relationship. This advance in other sciences has proved a great value and importance of physics in applying new ideas in developing new tools for investigation and in opening new field of study [1].

In Ghana, there is a problem of teaching of physics and science in general. The fact is the most of the teachings are done in theoretical manner after which most of the students find it difficult to practice them, therefore not having interest in the subject. The concern has led many researches into investigating certain teaching methods for practicals [2] For example, Graham (1986) investigated the impact of demonstration in teaching students of a secondary school in Cape Coast. He concluded that a topic is well understood by the students if the students are made to acquire the practical skills of the topic [3]. Similarly, Koomson (1991) investigated the effectiveness of the experimental method to teach selected physics concepts to students in a college at Kumasi [4].

The teachings of most tutors make the student have less or lack interest in the subject. Thus, most of the tutors do not put the students before the practicals. For effective teaching, the teacher should allow the students to be active contributing agents to their own learning. The teacher is not allowed to present the fact and theories to students so as to help the students to overcome any challenges before them[5]. Alexander Amediku (1995) gave his view on the effectiveness of the integrated method of guiding students to form their own physics concepts in Electricity [6].

By applying Piaget's Theory of Intelligence to problems of educational practice, Piaget provides a description of how the child's mental function spontaneously develop, while an educator wants to know what can be done or what must be done in order to achieve certain educational objectives which can be as simple as acquisition of information or as complex as adoption of described attitude [7]. Wahlberg (1970) in reviewing the results of educational research concluded that most variance in students performance can be attributed to differences in aptitude, a smaller amount to learning environment and that differences in instructional methods have least effect [8]. Brunner (1960) and Piaget (1971) sharing their views came out that there is little or no experimental evidence on which to base decisions on a great many aspects of the educational process [7, [9].

In this view, this study has been structured in such a manner as to cover both the theoretical aspect and hand-on activities in physics. This would encourage students to build up their interest in the scope of science, since the research covers the presentation and analysis of data.

II. OBJECTIVES

- To highlight the importance of practical work in the study of physics.
- To identify the roles teachers play during physics practical session.
- To identify whether, the hand-on activities are effectively being implemented by teachers in Senior Secondary Schools precisely Saint John's Secondary School during teaching and learning process.

- To identify any problems encountered by students during physics practical session.
- To give suggestions and recommendations as to how the scheme would be improved.

III. HYPOTHESIS

The hypothesis that can be considered for this study is as follows: **Students who spend more hours doing physics practicals acquire more scientific skills than students who spend less hours during physics practicals.**

IV. METHODOLOGY

A. Research Design

The study used for this purpose was randomised pre-test and post-test experimental design. This design was appropriate for the researcher because the data for this study were collected from sample of students from Ghanaian Secondary students in order to improve their level of physics through scientific skills acquisition.

B. Population, Sample Size and Sampling Techniques

Saint John's Secondary Schools has six classrooms for the science students with the total of 240. It was impossible however for the researcher to conduct the study on all the students due to factors such as time and financial constraints and proximity of the sample groups to the researcher. The researcher therefore made a sample of 60 students who were in SS2. The sampling procedure used was a random sampling. Sixty (60) students who were present took part in this exercise. Of these, thirty (30) students constituted the control group and the other thirty (30) constituted the experimental group.

C. Research Instrument

The instrument used to collect the data was randomised pre-test and post-test experimental design. The randomised pre-test-post-test experiment was designed to solicit the students to acquire scientific skills and to highlight teachers' roles during practical sessions. It was also intended to highlight problems students had encountered during practical session and solve problems not still solved and give suggestions and recommendations as to how the scheme could be improved.

The pre-test-post-test experiment consisted of some practical questions. The questions were in the form of standardized test that required the students' solutions by scientific skills (observation, manipulative skills, interpretation of diagrams, etc.) already required. After which the students drew their conclusion(s). This approach therefore helped the students as well as the teachers thereby improving the performance of students in practical physics and science in general.

The randomized pre-test-post-test design instrument which consisted of identifying Control and Experimental groups for the purpose of comparison was selected as the most applicable owing to the definite identifies of the sample fields. The two groups consisted of sixty (60) students who were SS2 students of Saint John's Secondary School, Sekondi for 1998 academic year. Both groups were made to have physics practicals on selected topics in optics as a pre-test during the third term of the 1998 academic programme. They were then post-tested after a period of eight (8) weeks on selected topics in mechanics.

D. Subject

The selection of the subject did not require any sampling method. The groups were self-selected based on their placement in their Senior Secondary School programme as science students. Thirty (30) who constitute the control group and the other thirty who constitute the experimental group both offer Biology with Physics and Chemistry. Both groups were students of Saint John's Secondary School, Sekondi-Ghana. In order to statistically ascertain the homogeneity of these groups, the F-test was used to compare the groups' means on the pre-test practical assessment test instrument.

E. Treatment Procedure

The treatment (Experimental) group consisted of thirty (30) students enrolled in the elective physics course. The group met for four (4) hours each week over a period of two (2) months. The researcher believed that students completing the course should have acquired some scientific skills in practical physics. The students were presented with numerous hands-on activities centred on both optical and mechanical experiences. The practical physics test instrument on optics was administered as the pre-test for both the Experimental and Control groups.

The control group consisted of thirty (30) students were opposed to theoretical physics of some topics in Optics and Mechanics after pre-test. Therefore, the students encountered few practical physics after pre-test. Upon completion of the course, both the experimental and control groups were made to take a physics practicals on selected topic in Mechanics as a post-test.

F. Data Analysis Procedure

The pre-test and post-test means as well as the standard deviations of the control and experimental groups were first determined from raw data. In a manner of that gave a quotient whose value exceeds or equal to unity, the value obtained was compared with a critical F-value obtained for 29 degree of freedom of P = 0.05 significant level. Similarly, the post-test means and standard deviations of both experimental and control groups were substituted into the pooled sample t-test formula. The calculated t-value was then compared to the critical t-value determined at the 58 degrees of freedom at P = 0.025 significant level[10].

In the collection of data, the following assumptions were made:

- The samples of each group were randomly and independently drawn from the population.
- Both groups were normally instituted each with mean (x) and variance.
- The two-tailed test statistical analysis at P = 0.025 level of significance was most appropriate for testing the hypothesis.

V. RESULTS

The F- test was used to compare the entry behaviours of the two groups using Pre-test data (Table 1). There was no statistically significant difference of P = 0.05 between the two groups. Similarly, the Post-test data was used to determine if the research treatment on the groups was effective. The groups were then compared using two–tailed test subject to the research hypothesis. There was a statistically significant at P = 0.025 level grade difference between these means.

A. The Pre-test Analysis

Table 1 below summarizes the data on the pre-test assessment of the control and Experimental groups in order to compare their entry behaviour.

Table 1
Performance of Groups on Pre-test

GROUPS	MEAN (X%)	STANDARD DEVIATIONS (S)	NUMBER (N)
CONTROL	48.63	12.78	30
EXPERIMENTAL	49.70	13.13	30

From the table above, the standard deviation for the Control group $S_{C\ =}$ 12.78 and that for Experimental group S_E = 13.13 with F- value calculated as 1.06. Using the F-test table, the critical F- value determine for 29 degrees of at P = 0.05 level of significance for each group is approximately 1.854.

Also, when the population ranges from samples normal and the population valances are equal, then the null hypothesis is supported as follows:

$$F_{calculate} \leq F_{critical} \quad [11]$$

Since the above values hold, the null hypothesis is supported. Thus, there was no statistically significant difference between the two groups' entry behaviours.

B. The Post-test Analysis

Table 2 gives a summary of data on the post-test assessment of the groups. This data is used to measure the effectiveness of the research treatment.

Table 2
Performance of Groups on Post-test

GROUP	MEAN (X %)	STANDARD DEVIATION(S)	NUMBER (N)
CONTROL	42.5	13.26	30
EXPERIMENTAL	53.0	15.40	30

The hypothesis being tested was that the post-test mean score of the control group (X_C) differs significantly from the post-test mean score of the Experimental group (X_E).

C. Decision

From the t-value obtained, the critical value t_o = 2.00 and the calculated t-value t =3.17.

The null hypothesis, H_O requires that $t_o = t$ whereas the research hypothesis H_1 requires that $t_o \neq t$, hence from the latter hypothesis there is a statistically significant difference between the two post-test mean scores of the control and experimental groups. Thus difference was not due to chance[12]

D. Result from Control Group

The highest and lowest scores obtained during the pre-test exercise were 75% and 25% respectively. It was found out that most of the students had an average score during the pre-test. Also, concerning the post-test exercise the highest and lowest score obtained were 73% and 22 % respectively. It was again found that most of the students had an average score during the post-test exercise. By comparing the two students (pre-test and post-test scores) of each student, it was realised that there was a significant decrease in the scores of most students. Only few of the students had the same scores. This therefore confirms **the Law of Disuse: "When practice is discontinued after establishing a bond between a stimulus and response, the connection gets weakened resulting in forgetting"[13].**

F. Result from Experimental Group

The highest and lowest scores obtained during the pre-test exercise were 79% and 23% respectively. It was found out that most of the students had an average score in the pre-test exercise. Also, during the post-test exercise, the highest and lowest scores obtained were 80% and 20% respectively. It was found out that most of the students had an above-average score during the post-test exercise. By comparing the two scores (pre-test and post-test scores) of each student, it was realized that there was a significant increase in the scores of most students. This also confirms the Law of Disuse as stated above.

VI. DISCUSSIONS

The researcher began this investigation by subjecting the two groups of the experimental design to a treatment in some aspect of optics and mechanics. He then pre-tested the groups; the results indicated a mean of 49.70% for the experimental group and 48.63% for the control group. The standard deviations for both experimental and control group are 13.13 and 12.76 respectively. By considering, the two-tailed f-test analysis of variance at p =0.05 level of significant, the means of the two groups were compared and it was found that there was no statistically significant difference observed at the 5% probability level. This suggested that the two groups were homogeneous and therefore comparable and it provided the necessary basis to pursue the investigation.

The hypothesis considered was that students who spent more hours doing physics practicals acquire more scientific skills than students who spent less hours doing physics practicals. This assertion was confirmed by the post test result of the two groups. It was found that average performance of the experimental group was better than that control group [that is 53.0% and 42.5% respectively]. A look at the post-test score lists [see tables 3 and 4] indicated that a maximum score of control was 73% and that of experimental was 74%. This narrow difference could be attributed to certain extraneous variables such as:

The effect of exposure to pre-test at the in caption of the experiment leading to practice effect and “test wiseness” or the part of some students who speculated a similar assessment in the target group instead of their being randomly selected (Campbell and Stanley, 1963). These factors notwithstanding, there was a generally more purposeful learning habit exhibited by the experimental group judging by their standard deviations of 12.40 as against 13.26 by the control group.

In testing the null and research hypothesis the t-test registered 2.00 at the 0.25 level of significance for 58 degrees of freedom. The calculated t-value was obtained as 3.17. The research hypothesis that the post-test mean score of the control group differs from the post-test mean score of the experimental group was thus accepted in preference to the null hypothesis, on the basis that t (3.17) was greater than t_o (2.00).

VII. RECOMMENDATIONS

The study recommends the appropriate methods used by teachers in delivering instructions at the early stage (Senior Secondary School 1). Also, students’ cognitive styles should be promoted by allowing them to discover things for themselves through experiments. Again, studies should be conducted at all grade levels, all districts, secondary schools, etc. in physics as well as other disciplines such as Biology, Chemistry, etc. Furthermore, every Districts and Regional capitals should be encouraged to have furnished Science Resources Centres to promote hands-on activities of students. Finally, this study should help reappraise the development of curricula by the Ghana Education Service.

VIII. CONCLUSIONS

In conclusion, the data obtained indicates that those students who spent more hours doing physics practicals acquire more scientific skills than those who spend lesser hours doing physics practicals. Therefore, the hypothesis stated above holds. Also, by comparing the critical t-value (2.00) for the post-test analysis with the calculated t-value (3.17) for the post-test analysis, it proves that exposing students to more practicals or hands-on activities and with good teaching methods, techniques and skills develop an acquisition of scientific skills, thereby enhances students’ understanding of physics concepts.

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AUTHORS

First Author – Emmanuel Atta Williams, M Phil (Physics) & Postgraduate Dip. Education, Department of Electrical/Electronics Engineering, Takoradi Polytechnic, Ghana. , E-mail: attawilliams@yahoo.com/attawilliams@gmail.com