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7

AN ASSESSMENT OF SENIOR SECONDARY SCHOOL PHYSICS LABORATORY PRACTICE

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ABSTRACT

This study aimed at unveiling the conduct of senior secondary school physics practical in Uyo Municipality of Akwa Ibom State. It was discovered, through interviews using students and teachers' questionnaires as well as on-the-spot observations of two practical physics sessions, that most laboratory skills were poorly developed in students in the area. These skills include computational, observational, communicative, and to some extent, manipulative. It was also discovered that a traditional pattern of instruction which does not provide for reflective thinking was widely in use in the area. The poor development of laboratory skills in students was therefore largely attributed to the use of traditional pattern of instruction. It was therefore recommended that problem-solving models be developed for practical physics in schools.

The laboratory has been recognised world-over among scientist, and science teachers as the centre for scientific experimentation. It is the workshop of the scientists – the very place where students are to learn most about a scientific method (Kruglak, 1949). Most science educators do agree to the fact that whatever grade level science is taught, the laboratory must be used not only to verify, but also to find and to investigate the process and products of science (Shuaibu and Otuka, 1981).

Literature is replete with the role and objectives of the laboratory in science teaching. Lee (1978), examining the role of laboratory instruction, affirmed its five major functions as fostering the inculcation of manipulative skill; process of science; knowledge of the subject and values.

Other researchers (Vitta, 1979; Dubravcic, 1979; Hofstein and Lunetta, 1982) have consented that appropriate laboratory activities can be effective in promoting logical development and the development of some inquiry and problem-solving skills. It is therefore necessary to find out whether or not practical physics exercises in Akwa Ibom State schools are helping in the development of the required laboratory skills. Although the present study is based on physics, its finding could be applied to other areas of science.

PURPOSE

The purpose os this study is to answer the following research questions:-

1. How are physics practicals carried out in schools in Uyo Municipality of Akwa Ibom State?
2. Do the patterns of instruction in practical physics allow for or foster the development of laboratory skills (manipulative, observational, computational and communicative) in students?

PROCEDURES

Seven schools were randomly selected from the ten well equipped schools with qualified physics teachers in Uyo Municipality of Akwa Ibom State. This samplying criterion was necessary so as to ensure that practical physics sessions were regularly carried out in the schools chosen. Experience has shown that in schools where either physics laboratories are poorly equipped or there are no qualified physics teachers, practical work is either haphazardly carried out or not carried out at all. Since this study was aimed at unveiling the conduct of practical physics as well as its impact on the development of laboratory skills in students, it was imperative to ensure that subjects in the study had been exposed to practical work on a regular basis.

A total of seven (7) physics teachers and twenty-six (26) SS 2 physics students responded to the instruments used in this study (the number of physics students in the year considered was deplorably small).

The procedure employed in the study included:

(i) a review of WAEC Chief Examiner's reports in practical physics from 1982 to 1989;

(ii) a review of some practical physics textbooks (Moss, 1971; Draycott and Lyon, 1974; and Armitage, 1985).

(iii) interviews using physics teachers' and physics students' questionnaires; and

(iv) on-the-spot observation of practical physics sessions in schools.

INSTRUMENTS

The physics teachers' questionnaire (PTQ) was made up of nine (9) items, excluding those of demographic variables, constructed using likert scale of measurement. The items were derived from the problems of students in practical physics as assessed by teachers. These were designated as "student oriented" (SO). The questionnaire also assessed teachers' methods, procedures and assessment of students' practical work in physics. These were designated as "Teacher Oriented" (TO).

The physics students' questionnaire (PSQ) had nine (9) items excluding those of demographic variables, aimed at revealing students' attitudes towards the problems encountered in practical physics. Both PTQ and PSQ were face-validated with test-retest reliability coefficient of .86 and 79 respectively.

The on-the-spot observation was carried out during practical physics sessions, the first being on mechanics and the second, on optics. In each observation, assessment of each laboratory skill exhibited by students was done using laboratory performance code constructed and validated for the purpose. The code simply contains required actions which when exhibited will portray the development of each laboratory performance exhibited will portray the development of each laboratory skill (see appendix). A full text of the laboratory performance code has been described by Onwioduokit (1989). Students actions were scored as either being correct or incorrect with reference to the performance code. Three observers took part in observing a total of twenty-six students. There was an inter-rater reliability coefficient of 0.8.

MODE OF DATA ANALYSIS

Since the study involved no hypothesis, Teachers' and Students' responses were analysed using percentages while the outcome of on-the-spot observations was analysed with both percentage and frequencies.

RESULTS

A. **Teacher Responses:** Table I indicates the responses of physics teachers to items in PTQ.

TABLE I

A Summary of Responses Made by Physics Teachers to Items in PTQ

ITEMS	Nature of	N	Very often	Often	Not often	Not at all
1. Do you provide students with theory of each experiment before practical?	TO	7	6 (85.7)	1 (14.3)	–	–
2. Do you allow students to carry out a practical work before providing the theory?	TO	7	–	–	–	7 (100.0)
3. Do you demonstrate each experiment before allowing students to carry out theirs?	TO	7	6 (85.7)	6 (14.3)	–	–
4. How often do you provide detailed instructions in practical physics?	TO	7	(100.0)	–	–	–
5. How often do you employ other forms of assessment besides the traditional grading of practical note books?	TO	7	–	–	–	7 (100.0)
6. Are your students able to follow instructions given in practical physics manuals?	SO	7	3 (42.8)	2 (28.6)	2 (28.6)	–
7. Are your students able to handle apparatuses well?	SO	7	5 (71.4)	1 (14.3)	1 (14.3)	–
8. How often do your students encounter mathematical problems in practical physics?	SO	7	2 (28.6)	2 (28.6)	2 (28.6)	1 (14.2)
9. Are your students able to select appropriate information and skills in solving practical physics problems where no clear instructions given	SO	7	–	2 (28.6)	–	5 (71.4)

TO — Teacher Oriented
SO — Student Oriented
Figures in parentheses are in percentage.

B. Student Responses:

TABLE II

A Summary of Students' Responses to PSQ

	N	Very Often	Often	Not Often	Not at all
1. How often do you like to engage in practical physics?	27	20 (74.1)	6 (22.2)	1 (03.7)	–
2. How often are you able to link theories with practicals in physics?	27	15 (55.6)	5 (18.5)	5 (18.5)	2 (07.4)
3. How often would you prefer to be given minimum instructions in solving practical problems?	27	9 (33.4)	10 (37.0)	2 (07.4)	6 (22.2)
4. How often are you a able to follow instructions in the practical class?	27	12 (44.5)	3 (11.1)	8 (29.6)	4 (14.8)
5. Do vou handle physics apparatuses well?	27	18 (66.7)	5 (18.5)	4 (14.8)	–
6. How often do you encounter mathematical problems in practical physics?	27	12 (44.5)	3 (11.1)	7 (25.9)	5 (1815)
7. Where instructions are clear, how often do you know what you are required to do in solving practical physics problems?	27	5 (18.5)	6 (22.2)	4 (14.8)	12 (44.5)
8. How often do you think reflectively on practical physics problems before solving them?	27	2 (07.4)	5 (14.5)	4 (14.8)	16 (59.3)
9. How often do you actually understand the significance of physics problems solved?	27	4 (14.8)	6 (22.2)	12 (44.5)	5 (15.5)

Figures in parentheses are in percentage.

It could be seen from Table I above that teachers very often provide detailed instructions coupled with demonstrations in practical physics (items 3 and 4). Responses to items 8 and 9 show that students have problems with mathematics and are also unable to think reflectively in problem situations where instructions are not very clear. Students with mathematicss problem as well as those not being able to think reflectively were also observed during on-the-spot observations. Moreover, the three physics textbooks assessed showed detailed instructions that include: aim of experiment, theory of experiment, nature of data required; and sketch of required graph. These provisions hinder the development of reflective thinking in students.

Judging from Table II, 14.5% of students very often have mathematical problems in practical physics (item 6). About 59.3% of students do not engage in reflective thinking during practical sessions (item 8) while 44.5% of students do not comprehend the significance of practical physics problems solved (item 9). Moreover, 44.5% of student do not know what to do when instructions provided in practical physics manual are not very clear. The author considers those percentages high enough to cause a great setback in the development of laboratory skills in students.

During the on-the-spot observations, the existence of these problems in students' practical work was confirmed. Most students were seen rushing at the apparatuses without taking time to form a mental framework (conceptualization) of the problems involved. This confirms the WAEC Chief examiners report that students do not actually understand the physics of what they do in the laboratory. For the period considered, the fact of students not understanding the physics of what they do in the laboratory was the consistent remarks made by the WAEC Chief Examiner in physics.

Data in Table 3 were obtained through the use of laboratory physics performance code (Onwioduokit, 1989) during on-the-spot observations of students' practical physics sessions. Performance of each student was scored as being right or wrong. For instance, the table shows that our of 26 students, 20 were able to handle apparatus correctly during the first session while 22 students were found to handle apparatus correctly in the second session. On the overall, Table 3 shows that 81 out of 156 (that is, 26 × 6) performances were correct during the first session while 125 were correct in the second session. The observed better performance of students during the second session may have resulted from practice effect.

TABLE 3

Summary of Results of First and Second Observations With Regards to Students' Exhibition of Manipulative Skills

	Handling of apparatus		Setting up of apparatus		Bearing of apparatus		Experimen- posture		Manipulation of apparatus		Eye-hand co-ordination		Overall frequency/percentage	
Observations	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
*Correct	20	22	12	21	11	16	10	24	13	20	15	22	81	125
*Incorrect	06	04	14	05	15	10	16	02	13	00	11	04	75	31
%Correct	77.9	84.6	46.2	80.8	42.3	61.5	38.5	92.3	50.0	76.9	57.7	84.6	51.9	80.1
%Incorrect	23.1	15.4	53.8	19.2	57.7	38.5	61.5	07.7	50.0	23.1	42.3	15.4	48.1	19.9

* given in terms cf the number of correct and incorrect students performances.

Considering the two sessions together, there were 206 (66.0) correct performances out of 312 (that is, 156 × 2) performances. Although this shows a fair acquisition of manipulative skills in students, poor exhibition of this skill was seen in the area of "bearings of apparatus". Only 27 (that is, 11 + 16) out of 52 (that is, 26 × 2) performances in this area were correct. This forms 51.9% of the performance. The remaining students were seen taking readings from metre rules, for instance, at a slant.

TABLE 4

Summary of the Results of First and Second Observations With Regards to Students Exhibition of Observational Skills

	Relevance of data		Accuracy of data		Number of data		Significant figure		Recognizing error		Overall Frequency/percentage	
Observation	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
*Correct	26	26	06	08	20	22	05	20	03	07	60	83
*Incorrect	00	00	20	18	06	04	21	06	23	19	70	47
%Correct	100	100	23.1	30.8	26.9	84.6	19.2	76.9	11.5	26.9	46.2	63.8
%Incorrect	0.0	00.0	76.9	69.2	23.1	15.4	80.8	23.1	85.5	73.1	53.8	36.2

*given in terms of the number of correct and incorrect students performances.

Table 4 above shows that 60 out of 130 (that is, 26 × 5) performances were correct during the first experiment while 83 performances were correct during the second experiment. On the whole, from the two sessions, 143 (that is 60 + 83) performances were observed to be correct out of a total of 260 (that is, 130 × 2) performances. This gives 55.0% overall correct performance and 45.0% of incorrect performance. Moreover, the table also shows that specific performances under the observational skills was very poor for both accuracy of data – 14 (that is, 26.9%) correct performances out of 52 for both observations; and ability to recognise errors in experiments – 10 (that is, 19.2%) correct performances out of 52. The best performances were seen in the ability to know relevant data (100% correct performances). The good performances in this area may have resulted from the cookbook nature of the practical exercises the student were engaged in.

TABLE 5
Summary of the Results of First and Second Observation With Regards to Students Exhibition of Computational Skills

	Suitable Scale		Graph Plotting		Calculation		Units		Substitution		Overall Frequency/percentage	
Observation	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
*Correct	05	08	08	06	03	04	09	21	17	20	42	59
*Incorrect	21	18	18	20	23	22	17	05	09	06	88	71
%Correct	19.2	30.8	30.8	23.1	11.5	15.4	34.6	80.8	65.4	76.9	32.3	45.4
%Incorrect	80.8	69.2	69.2	76.9	88.5	84.6	65.4	19.2	34.6	23.1	67.7	54.6

*given in terms of the number of correct and incorrect students performances.

It could be seen from Table 5 above that 42 out of 130 (that is, 26 × 5) performances were correct in the observation of the first session while the second session had 59 correct performance. On the whole therefore, there were 101 (that is, 42 + 59) correct performances out of 260 (that is 130 × 2) performances exhibited under computational skills. This puts the overall percentage of correct performances of students at 38.8% and incorrect performances at 61.2%. Also, except for 'units' and 'substitution' specific correct performances under these skills were very low: suitable

scale (25.0%), graph plotting (26.9%), and calculation (13.6%) for the two observations combined.

TABLE 6
Summary of the Result of First and Second Observations With Regard to Student's Communicative Skills

Observation	Answer to questions		Discussion of result		Conclusion		Overall frequency/per.	
Observation	1st	2nd	1st	2nd	1st	2nd	1st	2nd
*Correct	10	19	08	04	15	02	33	25
*Incorrect	16	07	18	22	11	24	24	53
%Correct	38.5	73.1	30.8	15.4	57.7	19.2	42.3	32.1
%Incorrect	61.5	26.9	69.2	84.6	42.3	80.8	57.7	67.9

*given in terms of the number of correct and incorrect performances.

As shown in Table 6, there were 33 correct performances out of 78 (that is, 26 × 3) in the first observation. During second observation, 25 correct performances were observed. On the whole therefore, there were 58 (that is, 37.2%) correct performances out of 156. The highest correct specific performance was on giving answers to question (55.8%) while the lowest was on the discussion of results (23.1%).

DISCUSSION OF RESULTS

In Table 1, it was seen that majority of teachers (85.7%) very often provided theoritical background of experiments before exposing their students to practical physics sessions. In the same way, 85.7% of teachers admitted demonstrating experiments for students, very often and 100.0% provided students with detailed instructions in practical physics. It could be seen, from these responses, that a traditional pattern of instruction in practical physics is widely in use in our schools. The observed helplessness in students in the face of unclear instructions (Table 1, item 9 and Table 2, item 7), the inability of students (59.3%) to think reflectively (Table 2, item 8); as well as the inability to know the significance of practical physics problem solved Table 2, item 9), are all attributable to the use of the traditional pattern. This is because the traditional pattern gives too detailed instructions and made little or no provision for creative and reflective thinking.

From the on-the-spot observations carried out, overall correct performances formed 66.0% for manipulative skill; 53.0% for observational; 38.8 % for computational; and 37.2% for communicative skills. It could therefore be seen, from these result, that laboratory skills, except manipulative, are poorly developed in students. The satisfactory exhibition of manipulative skill may have resulted from the knowledge of the outcome of experiment since the traditional pattern was used. This observation agrees with previous researches (Adam, 1971; Newell and Kennedy, 1978). Although the performances seem to be satisfactory for observational skill, correct performances in ability to get accurate data (26.9%) and to recognise errors (19.2%) were very low. These two sub-skills are very crucial when considering the development of observational skills.

It is probably due to poor development of laboratory skills in students that WAEC results in physics is consistently not satisfactory in most schools.

CONCLUSION AND RECOMMENDATION

From the outcome of this survey study, it is concluded that, practical skills are poorly developed in physics students in Uyo Municipality of Akwa Ibom State. In spite of high marks that students seem to score in practical physics in school, they seemed not to have properly understood the physics of the practicals they performed.

Since a traditional pattern of practical physics, that is, a cookbook pattern is prevalent in schools, a conclusion is also drawn that traditional pattern of physics laboratory practical does not help in fostering laboratory skills in students.

It is therefore recommended that problem-solving models, suitable for solving practical problems in physics, be developed and promoted.

APPENDIX

LABORATORY SKILLS AND PERFORMANCE CODE (LASPEC)

1. **Manipulative Skills:**

This has to do with psychomotor variables such as:

(i) handling of apparatus;
(ii) setting up of apparatus;

(iii) manipulation of apparatus; and
(iv) eye-hand co-ordination.

The performance code as used in the present suty contains the following items:-

(a) Good handling of apparatus: This is shown by confidence in handling apparatus and having a proper grip of them.
(b) Setting up of Apparatus: Here, the emphasis is on the positioning of apparatus.
(c) Bearing of the Set-up Apparatus with the Horizontal Plane: The emphasis here is on the orientation of apparatus.
(d) Experimental Posture: This has to do with the position of students while carrying out the experiment, especially while manipulating the apparatus.
(e) Manipulation of Apparatus: This has to do with appropriateness and extent of displacement of apparatus starting and stopping techniques.
(f) Eye-hand Co-ordination: This assesses the ability to use the eyes and hands together in manipulating apparatus and in taking readings.

2. **Observational Skills:**

This has to do with the following abilities:-

(i) oberserving changes in dependent and independent variables;
(ii) detecting errors – personal, random, and/or systematic and taking precautions and
(iii) recording data.

The performance code contains the following items:-

(a) Relevance of data
(b) Accuracy of data
(c) Number of readings
(d) Consistency of data (in terms of decimal figures)
(e) Recognising errors and taking appropriate precautions.

3. **Computational Skills:**

This involves mathematical know-how such as:

(i) meaningful arrangement of data;
(ii) graph plotting;
(iii) calculation; and

(iv) evaluation of solutions.

The performance code contains the following items:

(a) Use of Suitable Scale: A scale is only considered suitable when the graph occupies at least one-third of the given graph sheet.

(b) Plotting of Points: Points are considered correctly plotted only when they are plotted within self-squares on both sides.

(c) Calculation: In the case of slope, for correct calculation, dx or dy must be correct.

(d) Appropriate Units: This are seen on tables of values and on graphs. Derived units are not considered at school level.

(e) Substitution into equations.

4. **Communicative Skills:**

This involves techniques in:

(i) answering and/or asking questions;

(ii) making conclusion(s) about physical problem and its solution.

The performance code contains the following items:

(a) Relevance of questions asked.

Discussion of Experimental Findings: This is done by giving physical significance of the slope, for instance, intercept(s) and that of the problem solved.

(c) Making useful conclusion, suggestions for improvement, and using appropriate language of expression (reported speech).

Note: Each performance under each skill is either scored 'correct' or 'incorrect' as the case may be.

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