ASSESSMENT OF PHYSICS TEACHERS’ PRACTICAL SKILLS CAPACITY AS BASIS FOR IMPROVING TEACHER RE-TRAINING PROGRAMMES

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Abstract
The study examined the skills capacity of serving physics teachers to effectively guide their students in physics practical sessions. Specifically, the study attempted to determine the extent to which physics teachers’ skills capacity to guide practical sessions was relative to years of teaching experience, qualification and gender. One hundred and forty serving physics teachers (male - 95; female – 45) were randomly drawn from a population of 302 physics teachers in public and private schools in Cross River State, Nigeria to constitute the sample for the study. Data were obtained using the Physics Teachers’ Practical Ability Test (P-PAT), which was adapted from the 2011 WASSCE Alternative to Practical Physics Paper 3. The instrument consisted of two parts: Part A (sought information about teachers and school teaching environment) and Part B (required teachers to answer the questions already standardized by WAEC). Relevant data were analysed using the 2-way Analysis of Variance to test the hypothesis that teachers’ skills capacity was not significantly influenced by years of teaching experience, qualification and gender. Results showed that years of teaching experience and qualification significantly influenced teachers’ skills capacity. It was recommended, among others, that packaging of content for teachers’ re-training programmes should be based on prior assessment of the skills and
competencies to allow for meaningful engagement of the teachers during the exercise. This will ensure that quality physics practical instruction is delivered to students which is basic for the promotion of economic development in Nigeria.

Key words: Assessment, Physics, Practical, Skills, Retraining

Physics is the study of matter in relation to energy in space and time. The study of physics is very critical in science education programme. The knowledge of physics finds application in all other science and non-science subjects in varying intensities. To this extent, students’ achievement in physics is very fundamental for further studies in science and technology disciplines in tertiary institutions. This has accounted for the efforts towards ensuring that the teaching and learning of physics in schools is effective.

Nations, generally, have accepted science education as key to their technological development. This was aptly demonstrated by the United States of America in the early 1960s shortly following the technological feat of the defunct USSR in 1957, namely, the Sputnik episode. The Americans took immediate steps to revolutionize their science education programme in schools. New school science curricula were developed, namely, the Biological Sciences Curriculum Study (BSCS – Yellow and Blue versions), the Physical Science Study Committee (PSSC) course, the Chemical Education Material Study (CHEM Study); new methods of teaching science were explored (e.g. the discovery method – with its different shades of descriptions and applications). These actions accounted substantially for the sound technological advancement of the United States of America and the height the nation has attained today. Other developed nations followed the same pattern, namely, refocusing their science education programme – in terms of content, delivery and relevance – and they have similar results. Our quest for technological development, critical for economic development, must equally be propelled by effective science education programme of which the teaching and learning of physics is integral and fundamental.

Over the years, students’ performance in physics (indeed the science subjects) in Senior Secondary Certificate Examination (SSCE) at credit level and above has remained poor (< 40%). In fact, not only is the performance poor, students’ enrolment in physics has hardly attained 40% of total enrolment in SSCE at any given year. For instance, between 2002 and 2004, students’ enrolment in physics stood at 261,687 (28%), 280,818 (30%), and 270,028 (32%) of the total enrolment (using English as basis) of 925,289, 939,507 and 844,540 respectively (Nnaka & Anaekwe, 2011).

The implication of this is that students’ intake into tertiary institutions to study key science courses cannot attain the recommended ratio of 60:40 in admission policy
The concomitant frustration this brings is not only on the students but also on Nigeria as a nation whose National Policy on Education provision on admissions between science and non-science courses has never been attained and may not likely be attained unless the inhibiting factors are resolved. This is capable of bringing huge frustration on our efforts towards economic development. Young Nigerians with aptitude for science cannot actualize their dreams; our oil and gas sector remains largely managed by foreign personnel; joblessness, poverty and deprivation fuels anger and bitterness among the youth which snowballs into agitations and conflicts. These can be avoided (or possibly minimized) if we can get our science education right at all levels.

Many factors have been identified as responsible for the poor performance of students in physics in senior secondary schools. These include lack of equipped laboratories, lack of qualified teachers and other related teacher factors, curriculum overload, poor attitude of students and gender biases (Effiong, 2002).

Efforts have been made over the years to resolve these intervening factors. For instance, in Cross River State, government embarked on renovation of secondary schools, which includes the provision of equipped laboratory in such renovated schools; more science teachers have been recruited into the school system; sustainable teacher capacity development programmes such as the annual teacher re-training workshops are organized.

However, the impact of these interventions depends on their appropriateness. For the teacher re-training programme for instance, the begging question is: are the areas of incompetence of the science teachers identified, analyzed and incorporated in the packaging of the re-training programme? Otherwise, the tendency would be to expose the teachers to issues that may not exactly resolve their classroom teaching and students’ learning challenges. There is need, therefore, to assess the practical physics skills ability of serving physics teachers to determine the extent to which the outcome could serve as input in the packaging of the teacher re-training programmes in the State and wherever such is contemplated.

Physics practical is an important component of physics education. Kerr (1963) identified the aims of physics practical work, as may be applicable to other science practical works, to include:

i. Encourage accurate observation and careful recording;
ii. Promote simple common sense scientific methods of thought;
iii. Develop manipulative skills;
iv. Give training in problem-solving;
v. Fit the requirements of practical examination regulations;
vi. Elucidate the theoretical work so as to aid comprehension;

vii. Verify facts and principles already taught;

viii. Be an integral part of the process of finding facts by investigation and arriving at principles;

ix. Arouse and maintain interest in the subject;

x. Make natural phenomenon more real through actual experience.

In specific terms, Trowbridge and Bybee (1990) identified what should constitute the objectives of practical works in physics to include:

i. To develop skills in problem-solving through identification of problems, collection and interpretation of data, and drawing conclusions;

ii. To develop skills in manipulating laboratory apparatus;

iii. To establish systematic habits of record keeping;

iv. To develop scientific attitudes;

v. To learn (and apply) scientific methods of solving problems;

vi. To develop self-reliance and undependability;

vii. To discover unexplored avenues of interest and investigation;

viii. To promote enthusiasm for the study of science.

Studies have shown that students’ involvement in science practical work contributes significantly to their understanding of science concepts (Millar, 2009), learning of science process skills and attitudes (Johnstone & Al-Shuaili, 2001). Hence, practical work occupies prominent place in science education programme and has generated strong interest and research (Hodson, 1991; Osborne, 1998; Millar, 2009).

Physics practical work offer students opportunity to learn by doing “what scientists do” (Ajeyalemi, 2011). Unfortunately, this aspect of physics teaching is often ignored or ill-treated by teachers (Abimbola, 1994; Aramide, 1985; Ajeyalemi, 2011). Reasons often include lack of laboratory space and/or ill-equipped laboratory (Agbola & Oloyede, 2007; Ajeyalemi, 1983; Nwokedi, 1983), teacher incompetence (Ajeyalemi, 2011; Adesoji & Arowosegbe, 2004) and lack of time (Akpan, 1999).

Given the importance of practical work in physics to the overall development of knowledge and skills of the physics students in secondary schools, it has become necessary to explore how teachers could be properly retooled to guide the students effectively. The teacher retraining programme readily is an option. This study was designed to strengthen this option and increase its impact on the participating teachers in terms of their capacity development.
Statement of the Problem

Students’ performance in physics is the aggregate of their performances in theory and practical works in the subject. Consistently, Chief Examiners’ Reports state that the continuing decline performance of students in the SSCE in science subjects may be traceable more to their poor acquisition of relevant science skills and consequent poor performance in the practical examination papers. With the observed poor preparation of students for science practicals (Agbo & Mankilik, 1999; Akpan, 1999; Maskill, 2000), students tend to perform poorly in science practical which leads to overall poor performance in the science subjects.

To reverse this trend, physics teachers (indeed all science teachers) must revisit students’ preparation for practical examinations. Teacher incompetence is a factor that could easily deter teachers from engaging in this meaningful task. It is appropriate to identify the competence level of physics teachers so that workshop programmes can be packaged to boost their competence to guide students in practical work. Therefore, this study is designed to assess physics teachers’ practical skills capacity as basis for the development of suitable programme for physics teachers’ retraining workshops.

Research Questions

The following research questions were explored:

i. Does physics teachers’ qualification and gender influence their physics practical skills capacity?

ii. Does physics teachers’ years of teaching experience and gender influence their physics practical skills capacity?

Hypotheses

The following null hypotheses were formulated to guide the study:

i. Teachers’ qualification and gender do not significantly influence their physics practical skills capacity.

ii. Teachers’ years of teaching experience and gender do not significantly influence their physics practical skills capacity.

Method

The study was a simple survey research conducted in Cross River State, Nigeria. Serving physics teachers in the public and some private secondary schools in the State constituted the population for the study. From this population of 302 teachers, one hundred and forty (N = 140; Male = 95, Female = 45) were selected through stratified (for gender) random sampling. The instrument used for data collection was the Physics-teacher Practical Ability Test (P-PAT). The instrument was adapted from the 2011 West African Senior Secondary Certificate Examination (WASSCE) Alternative to Practical Physics Paper 3 by the researchers. The instrument (P-PAT)
consisted of two parts. Part A sought information about the teacher and the school learning environment. Qualifications, years of experience in teaching physics in secondary schools and gender supplied by the teachers in Part A were extracted as data for the independent variables. Teachers were grouped into highly qualified (if credited with B. SC.Ed/M. Sc.Ed/Ph. D) or less qualified (if qualification indicated falls outside those listed earlier); highly experienced (if credited with 5+ years of teaching experience or less experienced (if number of years of teaching experience is less than 5 years); and male or female.

Part B required the teacher to answer the questions already standardized by WAEC. Teacher’s performance score on P-PAT represented a measure of the teacher’s physics practical skills ability (the dependent variable). The practical skills considered are:

i. Manipulative skills
ii. Observation/recording skills
iii. Ability to interpret results
iv. Ability to plan and carry out experiments

Scoring was done by the researchers using the marking guide developed by WAEC Examiners for the said examination. The teachers were all tested during the 2013 teacher retraining programme organized by the State Ministry of Education for serving secondary school teachers and were supervised by the researchers. The responses from the subjects to Part A and their performance in Part B constituted the data used for analyses in the study.

Results

Two hypotheses were tested in this study. First, a two – way ANOVA was performed on the data to test the null hypothesis that teacher qualification and gender do not significantly influence his/her physics practical skills capacity. The results are presented in Table 1.

Table 1: 2 x 2 ANOVA of the Influence of Qualification and Gender on Physics Teacher Practical Skill Ability

<table>
<thead>
<tr>
<th>Group</th>
<th>$\bar{X}_T$</th>
<th>$N_m$</th>
<th>$N_f$</th>
<th>$\bar{X}_m$</th>
<th>$\bar{X}_f$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly Qualified</td>
<td>49</td>
<td>22</td>
<td>52.22</td>
<td>51.73</td>
<td>51.98</td>
</tr>
<tr>
<td>Less Qualified</td>
<td>46</td>
<td>23</td>
<td>42.11</td>
<td>41.78</td>
<td>41.95</td>
</tr>
</tbody>
</table>
The calculated F ratio of 21.28 is significantly greater than the critical F ratio of 3.91 ($p < .05; df = 1,136$). Hence, the null hypothesis is rejected. This means that teacher qualification significantly influenced the performance of the physics teachers in their performance on P-PAT. The highly qualified teachers had significantly higher mean ($\bar{X} = 51.98$) than the less qualified teachers ($\bar{X} = 41.95$).

Furthermore, a two-way ANOVA was performed on the relevant data to test the second null hypothesis that teacher years of teaching experience and gender do not significantly influence his/her physics practical skills capacity. The results are presented in Table 2.

**Table 2: 2 x 2 ANOVA of the Influence of Years of Teaching Experience and Gender on Physics Teacher Practical Skill Ability**

<table>
<thead>
<tr>
<th>Group</th>
<th>$N_m$</th>
<th>$N_f$</th>
<th>$\bar{X}_m$</th>
<th>$\bar{X}_f$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly Experienced</td>
<td>46</td>
<td>24</td>
<td>51.91</td>
<td>52.13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>52.02</td>
</tr>
<tr>
<td>Less Experienced</td>
<td>49</td>
<td>21</td>
<td>42.71</td>
<td>42.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>42.38</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience</td>
<td>252.28</td>
<td>1</td>
<td>252.28</td>
<td>10.15*</td>
</tr>
<tr>
<td>Gender</td>
<td>1.652</td>
<td>1</td>
<td>1.65</td>
<td>0.07</td>
</tr>
<tr>
<td>Interaction</td>
<td>6.738</td>
<td>1</td>
<td>6.74</td>
<td>0.27</td>
</tr>
<tr>
<td>Within</td>
<td>3378.76</td>
<td>136</td>
<td>24.84</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3639.43</td>
<td>139</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$p < .05; df = 1,136; F_{critical} = 3.91$
The calculated $F$ ratio of 10.15 is significantly greater than the critical $F$ ratio of 3.91 ($p < .05; df = 1,136$). Hence, the null hypothesis is rejected. This means that teacher’s years of teaching experience significantly influenced the performance of the physics teachers on P-PAT. The highly experienced teachers had significantly higher mean ($\bar{X} = 52.02$) than the less experienced teachers ($\bar{X} = 42.38$). As shown in Tables 1 and 2, gender and interaction were not significant.

**Discussion**

Data obtained in this study showed that teacher qualification and years of teaching experience significantly influenced the capacity of physics teachers to conduct physics practical in secondary schools. The more qualified, and more experienced teachers demonstrated higher capacity to guide students in physics practical lessons than the less qualified, less experienced teachers. These results are consistent with previous studies on the effects of teacher characteristics on teaching ability and students’ performance (Bajah, 1982; Maduabum, 1990; Akale, 1992, Odetoyinbo, 2004).

Data did not support the influence of gender on teacher capacity. Earlier study (Yoloye, 2002, 2004) also concluded that gender is not a serious factor in teacher/student performance if the teaching/learning environments are not biased against any gender.

One of the major findings in this study suggests that the more qualified, and more experienced teachers had higher capacity to guide students in physics practical lessons. This may be explained by the fact that owing to their acquisition of higher knowledge of the subject matter and pedagogical skills, through training and/or learning on the job over the years, such teachers had the competence and mastery of the requirements of the subject matter. The experienced teachers may likely take part in marking of external examination scripts or had the benefit of accessing the marking guides by attending yearly co-ordination exercises organized by examination bodies. These activities positively impact on the teachers’ knowledge base and influence job performance.

For this category of teachers, retraining must focus on sharpening their existing skills, updating their knowledge and increasing their self confidence in task performance. Otherwise, the retraining exercise would be considered time wasting, boring and of no impact. Against this background, such teachers would give low rating to government effort on teacher retraining policy despite the huge resources expended on the project. In order to avoid this negative outcome of a well-intended project, it becomes necessary to stratify teachers according to qualification and years of teaching.
experience and exposing different groups to treatments that would be considered most needful for each category.

The finding in this study that less qualified and less experienced teachers performed poorly on P-PAT also gives cause for concern. You do not give what you do not have. The knowledge and skills tested in P-PAT were simply target learning outcomes for secondary school students. If the teachers performed poorly on such tasks, it simply shows that they do not possess the capacity to guide students in practical lessons in the subject. Hence, government and other operators of secondary schools must ensure that the right caliber of teachers are engaged in the school system to enable the students benefit maximally from their schooling experience. Otherwise, we would continue to lament over poor performance of students in external examinations which breeds frustration, anger, agitation, joblessness, poverty and economic slowdown.

**Conclusion**

While strongly encouraging continuous retraining of serving teachers in the school system, the outcome of this study shows that teacher qualification and years of teaching experience should be taken into perspective in planning and packaging the retraining programme so that all teachers (both highly qualified/experienced and less qualified/experienced teachers) would benefit maximally from the programme. The current practice of joining all teachers and subjecting them to the same retraining experience yearly may be counterproductive despite huge resources that may be expended by government or its agencies.

**Recommendations**

Based on data obtained in this study and the conclusion reached, we recommend that packaging of content for teachers’ re-training programmes should be based on prior assessment of the skills and competencies to allow for meaningful engagement of the teachers during the exercise. To this extent:

1. Serving teachers should be grouped into two categories (a) qualified and experienced category (who should possess B. Sc.Ed/M. Sc.Ed, Ph. D and have 5 years and above teaching experience); (b) less qualified and less experienced (who may possess those qualifications outside such described above and have less than five years of teaching experience).

2. Each group should be exposed to differently packaged retraining programme in terms of content, method and target outcomes.

These recommendations, if applied, would make the yearly retaining programme exciting and motivating as teachers would look forward to it with earnest expectations.
References


