

Science Education Reform Effort: Effect of Utilising Laboratory Method of Instruction on Students' Academic Performance in Science

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ABSTRACT – *Developing practical skills is fundamental to effective science education. This is a quasi-experimental research designed to investigate how students fare when teachers use appropriate laboratory methods for classroom instruction. Participants were 60 science education 200level undergraduates who were randomly assigned into experimental and control groups to have two equivalent groups. Two null hypotheses were postulated and tested. A researchers-made instrument tagged “Science Concept Achievement Test” (SCAT) was administered on all the research subjects after applying the treatment to the experimental group. Validation of SCAT was done through vetting by two experts who are professors of science education. The instrument was then pilot-tested to establish its internal consistency which yielded a reliability co-efficient of 0.73 using split-half method before actual usage. Data collected for the study were statistically analyzed using mean, standard deviation and t-test analysis. The results obtained showed that (1) Students in the experimental group performed better than their counterparts in the control group; (2) Females students performed better at tasks than their males counterparts in the experimental group. Recommendations made to teachers included the use of appropriate laboratory methods to facilitate science instructions and employ more girl-friendly approaches to help female students build more confidence in school science.*

Keywords---- Laboratory, practical orientations, gender, academic performance.

1. INTRODUCTION

Current trends in the advancement and sophistication of Information and Communication Technology (ICT) applications globally call for more effective ways of communicating scientific instructions in our schools. Learning “how to use” science for economic growth is so overwhelming that everyone encounters scientific experiences daily. From the remotest hamlet to the most advanced city, the impact of science is felt at home, workplace, at school, on the road, at the industries, shops, markets, public utilities and in an unending list of experiences. The effectiveness of any science course hinges on the quality of active learning experiences acquired by students while studying the course. Kardash and Wallace (2001) stressed that undergraduates are only made passive listeners in the science classes when their Faculty replaces laboratory instructions with mere explanations of scientific concepts. Some science educators such as Bajah (1990); Okeke (1990); Okebukola (2006) and Omotayo, Popoola & Adedokun (2009) identified laboratory practical work as the core of science learning. Okeke, (1990) stressed that practical aspect of science clearly stands out as the validation point for whatever is taught theoretically in science. Science laboratory and its facilities are the instructional facilities that help students learn what science is and how the scientists carryout their investigative activities. Ganjang,(1995) asserts that one could learn many science concepts theoretically by other methods of instruction. However, it would be extremely difficult if not impossible to acquire science process skills and imbibe scientific attitude without the use of science laboratory and its facilities.

Great emphasis placed on practical approaches to science teaching dated back to recent past where Woolnough and Allsop (1985) reported that quality time and effort to small group practical work is devoted to science teaching in U.K and Canadian schools. Orpwood and Souque's(1984) reported similar situation in their analysis of science education in Canadian schools where laboratory works were geared towards illustrating facts and theories presented in the class to obtain precisely the right answers to the problem situations. Although these are comments about schools in England and Wales, it could well apply to practice in the third World countries where practical orientations in science is far from the ideal.

Nigeria as a nation is conscious of scientific literacy as reflected in her education policy which places high premium on science. The national policy on education (NPE, 2004) has the policy document deliberated embroidered with scientific imperatives. In spite of all the emphasis being placed on practical approaches for effective science teaching however, many educational institutions still teach and learn their science more theoretically than employing practical approach. Otuka, (1994) reported a neglect of practical aspect of physics lessons due to inadequacy/lack of facilities to teach the subject. Similar situation was reported for Biology and Chemistry (Okebukola, 1988). Other reports frequently cited in available literature specify non availability or empty laboratories (Ajayi & Adedayo, 2011, Owolabi, 2011). Ganjang (1995) and Adedayo (2011) found that many schools still share laboratories and those without any found it very difficult to organize practical lessons.

The situation in discourse has made many Nigerian undergraduates to jettison laboratory practical method of instruction. An earlier work by Omotayo, et al, (2009) showed that about 48% of their respondents considered practical lessons in science as mere waste of time. Science educators such as Osborne, Simon and Collins, (2003), Okebukola, (2006) and Omotayo and Olaleye, (2008) clearly identified poor practical knowledge of scientific skills as a major impediment contributing significantly to underachievement in science among college students. From all indications, the state of practical science education in Nigeria is far from the ideal. With the challenging vastness of globalization, the use of inappropriate science teaching methods is detrimental. Such methods convey haphazard knowledge of science in all ramifications. Based on this premise, this study was designed to investigate the effect of utilizing laboratory method of instruction on students' academic performance in science. This research unveiled the difference between the academic performance of students taught science using laboratory method of instruction and those taught with other conventional methods. It also showed the impact of gender on academic performance among respondents in the experimental group.

2. RESEARCH HYPOTHESES

Two null hypotheses were postulated and test. These are:

HO₁: There is no significant difference between the performances of students taught science using laboratory method of

instruction and those taught without using laboratory methods.

HO₂: There is no significant difference between performances of males compared to that of females taught science using

laboratory method of instruction.

3. MATERIALS AND METHODS

3.1 Research Design

The design used was a quasi-experimental non-randomized post-test only which was administered on both the experimental and control groups after treatment of the experimental group. It is diagrammatically represented thus:

$O_1 \times O_2 =$ post test (experimental group)

$O_3 - O_4 =$ post test (control group)

Where "X" means treatment and "___" means no treatment

3.2 Participants

The research subjects were 60 science education students drawn from among the 200 level undergraduates of Faculty of Education in Ekiti State University, Ado-Ekiti, Nigeria. Thirty-Six (36) males and 24 female students participated in the study. Equal number of male and female students was purposively assigned to both the experimental and control groups.

3.3 Procedure

One of the first semester courses coded ISE 205 (Air and Water) was isolated for the study. The course, (ISE 205) was taught to the experimental group using all required laboratory facilities for appropriate laboratory method of instruction while the control group was taught the same course (ISE 205) using other conventional method such as mere explanation of scientific concepts without using appropriate laboratory facilities and method of instruction. The population of males and females were evenly distributed in groups i.e. 18 males, 12 females in both the experimental and control groups. The lessons lasted for the first half of the semester and the post treatment test was administered on both groups. Analyses of the data collected were presented in this research report. The study was carried out during the 2010/2011 academic session.

3.4 Instrumentation

A researcher - made Science Concept Achievement Test (SCAT) was administered as the research instrument for the study. The SCAT contained a 20- item objective test items drawn along the thematic lines of the topics used as treatment for the research. Internal consistency of the instrument was established through vetting by expert science educators (professors) to ascertain its face, content and criterion referenced validities. Its reliability was determined by pilot-testing the instrument using the split-half method. A reliability co-efficient of $r = 0.73$ at 0.05 level of significance was obtained before usage of the instrument for the research.

4. RESULTS

Statistical analysis of the data collected for this research employed mean, standard deviation and t-test analysis as shown in the tables.

H_{01} : There is no significant difference between the performances of students taught with laboratory method of instruction and those taught using conventional methods.

Table 1: t-test analysis of performance of respondents in the post-test for experimental and control groups

Group	N	Mean	SD	df	t-calculated	t-table	$P \leq 0.05$
Experimental	30	29.09	5.65	29	8.55*	1.69	Significant
Control	30	21.31	4.17				

Result on table 1 shows that the calculated t-value of 8.55 is greater than the table value of 1.69 at 0.05 level of significance. H_{01} is thus rejected. The finding thus indicate that there is a significant difference between performance of respondents taught with laboratory method of instruction and those taught using other conventional methods. Please note that students in the experimental group perform better at tasks than those in the control group.

H_{02} : There is no significant difference between performance of male and female taught science using laboratory method of instruction.

Table 2: t-test analysis of performance of males and females taught with laboratory facilities

Gender	N	Mean	SD	df	t-calculated	t-table	$P \leq 0.05$
Male experimental group	18	26.67	5.51	28	7.25*	1.70	Significant
Female experimental group	12	30.50	6.02				

H_{02} is also rejected because t-calculated (7.25) is greater than t-table value (1.70) at 0.05 level of significance. This result implies that there is a significant difference in performance between males and females students taught using laboratory method of instruction. The mean score for female group (30.50) indicates that females in the experimental group perform better at task than males with mean score of 26.67.

5. SUMMARY OF RESULTS

1. There is a significant difference between performance of students taught with laboratory method of instruction and their counterpart taught using other conventional methods.
2. Females students in the experimental group performed better than their male counterparts.

6. DISCUSSION

Findings of this research showed that students taught with laboratory method of instruction performed better than those taught with other conventional methods. One can simply deduce from the findings that students in the experimental group performed better because they were sufficiently instructed using appropriate laboratory facilities, hence, they were able to understand concepts taught in that course better and consequently scored higher marks than those in the control group. Laboratory practical method of teaching and learning science is a child-centered approach to learning where learners are made active participants in the teaching/learning process. This method of science instruction, if encouraged, would help students out of passive learning asserted by Kardash & Wallace (2001).

Schechtman & Leichtentritt's (2004) affective teaching strategies gave credence to laboratory method of classroom instruction. They emphasized that such classroom interventions showed a positive influence on pupil's academic achievement. They further reiterated sequel from their study that affective lessons help students to be more self explorative, less off-task and demonstrates less misbehaviour than they would in a regular routine teaching sessions. The problem of abysmal decline in performance in science and the ineptitude so prevalent in tertiary education can be addressed with frequent active learning approaches in science teaching. A system reported by (NUC 2002, Okebukola, 2006) can be nibbed in the bud if laboratory method of instruction is employed to teach science more creatively.

Another finding of this research showed that female students performed tasks better (means score 30.50) than their male counterparts (26.67) in the experimental group. Gender disparity in science, technology & mathematics (STM) has a long history and struggles. Literature abounds about male domination in science based disciplines (Ajayi and Adedayo, (2011). Likewise, a good number of researchers such as Omotayo, et al (2009) have indicated that male superiority over female in science achievement is still lacking as no conclusive empirical evidence to that effect is yet available. One of the findings of this research showed that female performed tasks better than their male counterparts when taught science using laboratory practical instructional method. This is an improvement on the made believe poor female performance in science. Badekale (1997) earlier identified similar situation in her study where she identified females coming up in science based discipline. As Betiku, (2002) asserted that the struggle against inequality in science might take time but equality in science will come. This research projects that time has come to put more efforts on how to combat the badly skewed inequality in STM education which has been in favour of male folks. Gender stereotyping in schools is fast becoming an old but odd practice. Girls and women should be sensitized to come out of self defeat, low levels of confidence and have their potentials in science brought to the lime light.

7. CONCLUSION

This research clearly identified laboratory method of instruction as a veritable tool for better achievement in science where chalk and talk and other conventional methods of teaching science have proven inadequate. Another finding of the study revealed that laboratory method of instruction can boost female students' performance in science. It is therefore an indispensable tool needed to encourage girls more in science learning. Based on the findings of this study, the following recommendations are made to improve standard of teaching and learning science:

1. Adequate provision of laboratories and appropriate facilities for science instruction in all tertiary institutions of learning.
2. Exposing girls to more practical skill acquisition as girl-friendly approaches to scientific orientations.
3. Proper accreditation of laboratory and its facilities for quality assurance in all institutions of higher learning.

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