Process-Based Teachers' Refresher Courses and Students' Acquisition of Science Process Skills in Process-Oriented Physics Lessons

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Doi:10.5901/jesr.2012.v3n7p101

Abstract

The study investigated the efficacy of process-based refresher courses on students' acquisition of science process skills in process-oriented physics lessons, in Abak Educational Zone of Akwa Ibom State. Four hundred (400) SS2 students in eight (8) intact classes were randomly selected and used for the study. The research instrument employed for the study were Refresher Course Instructional Package (RCIP) and a Test of Science Process Skills (TOSPS). The data obtained were analyzed using t-test statistics. Results of data analysis showed that: physics students who were taught process-oriented physics lesson in "mechanics and properties of matters" by physics teachers who were exposed to process-based refresher course acquired observational, manipulative, computational and communicative science process skills significantly higher than their counterparts who received the lesson from teachers who were not so exposed; physics students who were taught process-oriented physics lessons in "mechanics and properties of matter" by physics teachers who were exposed to process-based refresher course, acquired the cognitive science process skills marginally higher than their counterparts who received the lessons from teachers who were not so exposed. It was therefore recommended that teachers at all levels of educational structure should be trained and retrained accordingly.

Keywords: *Physics lessons, Science process, Refresher courses*

Introduction

Science process skills are the various mental and motor processes, which the scientists use to arrive at new knowledge (Nwana, 2000). These processes are so vital to scientific effort that no knowledge will result if they are not employed. These skills, according to Nwosu (1994) are: (i) Observing (ii) Measuring (iii) Classifying (iv) Communicating (v) Predicting (vi) Inferring (vii) Using space time relationship (ix) Questioning (x) Controlling variables (xi) Hypothesizing (xii) Defining operationally (xiii) Formulating models (xiv) Designing experiment/experimenting (xv) Interpreting data.

Science process skills can be summarized into cognitive, observational, manipulative, computational and communicative. According to Onwioduokit (2002).

> *Cognitive skills contains variable such as logical reasoning, reflective thinking, synthesizing, applying knowledge and creative thinking .... Observational skill has to do with using sense organs appropriately, observing changes in phenomenal effect as independent, recording of data, detecting inconsistencies or contradictions and detecting common features or characteristics among objects or events .... The sub-skills of manipulative skills include handling of objects, setting up apparatus, modeling eye-hand coordination, experimenting (manipulating variables) and finger dexterity ... Computational skills has to do with abilities*

required in quantifying empirical concepts, calculation based on data obtained, graph plotting, making quantitative deductions and being accurate in measurements….. The sub-skills of communicative skills involved here include reporting, questioning, answering questions, using appropriate language and drawing conclusion.

Several science educators have advanced the rationale for teaching, learning and assessing science processes. Furley and Harlen (1984) described the process skills as the foundation for both scientific inquiries and development of intellectual skills needed to learn concepts. Bybee et al (1989) identified these skills as having the enduring quality of enabling the individual acquire and process information and solve problems even when the information base changes.

Awodi, (1984) enunciated that science cannot be taught effectively without employing the processes of science, and neither can science be learnt effectively without the use of the processes of science. "The processes of science encourage the active involvement of pupils in the learning process. Rather than being a passive receiver of the knowledge generated by others, he is finding out things, validating knowledge and making discoveries" (Otuka, 1990, p. 191).

The Federal Republic of Nigeria (2004) stated that "science education shall emphasize the teaching and learning of science processes". This policy statement represents a paradigm shift from the traditional, teacher-centred approach to teaching (with it inherent emphasis on rote-absorption of products of science) to the children-centred, interactive learning (with emphasis on effective use of science process skills); and this new trend begs for capacity building through the instrumentality of in-service training of teachers, in the form of refresher courses for teachers.

Inservice training is either a short-term or long-term up-dating course, usually in the form of seminars, workshops and conferences or further studies and meant for teachers in active service (Owolabi and Danusi, 2005). Refresher course is a course designed to keep professionals informed of recent development in their field of knowledge or expertise (Geddes & Grosset, 2005). Zeitler (1981) showed that the training of inservice teachers in process-based learning promotes efficiency in implementing process-based curriculum which (Mohammed, 2007) lays emphasis on guiding students to develop process skills through hands on activities.

Incidentally, in Nigeria, unlike other countries, the retraining of teachers has not received the desired attention from Local, State and Federal Governments. There has not been any systematic attention to update regularly the knowledge and skills of teachers in the light of curriculum changes and wide society (Mohammed, 2007). Considering the cost (in terms of money and time) of retraining, it is necessary to explore the efficiency of a cheaper and faster alternative full-fledged retraining. One of such alternatives is the refresher course, designed and mounted by a process-oriented, specialist teachers on "process-based teaching/learning and students' acquisition of science process skills."

Research Hypothesis

To guide the researcher in conducting the research study, the following null hypothesis was formulated: there is no significant difference in acquisition of science process skills (cognitive, observational, manipulative, computational and communicative science process skills) between physics students taught by teachers who are exposed to refresher course and their counterparts taught by teachers who are not so exposed.

Research Method

Experimental research design was adopted for the study.The population of the study comprised all the senior secondary II (SS2) physics students in Abak Educational Zone (comprising Abak and Etim Ekpo Local Government Areas of Akwa Ibom State). Eight (8) schools were randomly selected, four (4) each from Abak and Etim Ekpo L.G.As. from among school that had SS2 enrolment of at least one hundred and fifty (150) students. Fifty (50) students in intact class were drawn from each of these schools to give a sample size of four hundred (400) students.

Procedure

The four intact classes were, by random process and in equal proportion, assigned experimental and control groups. The two intact classes in the former group were taught by teachers exposed to refresher courses, while the remaining two intact classes in the latter group were taught by teachers who were not so exposed. All four groups of students were taught by their respective physics teachers (here called professional/research assistants) in their respective schools.

To update the professional skills of teachers (research assistant) for the experimental group, in the light of changing emphasis in curriculum, which favour process-based teaching and utilization of science process skills, these teachers were exposed to a packaged refresher course. Designed by the researcher, the refresher course instructional package (RCIP) consisted of three discussion/demonstration sessions, of two hours per session and bordered on : (i) the inquiry nature of physics (ii) the active and inquisitive nature of students (iii) the rationale for teaching/learning science process skills (iv) evaluating science process skills (v) the performance/specific objectives of senior secondary physics curriculum (vi) process-based teaching method, as recommended by the Federal Republic of Nigeria (2004), in the National Policy Education (vii) science process skills and experimental physics (viii) process-oriented lesson notes. (ix) valid (video-taped) process-based lesson delivery. Each participating teacher was earlier given a typed hand-out to this effect.

The four intact classes were taught topics under the unit, "Mechanics and properties of matter". All the students (in groups 1 – 4) were post-tested.

Measuring Instrument

The measuring instrument employed for the study was a Test of Science Process Skills (TOSPS). It consisted of two questions in practical physics (in mechanics and properties of matter). Each question was composed of five (5) parts, each part containing two each of cognitive, observational, manipulative, computational and communicative sub-tasks, to give a total of 20 sub-tasks for the three questions. The question designed were representative of the activities for the process skills concerned.

The reliability of the TOSPS (using coefficient alpha method) was found to be 0.82. The face-validation of the TOSPS was done by a panel of three experienced physics education university lecturers.

Assisted by the research assistants, the TOSPS was administered by the researcher on the 400 SS2 physics students (the four intact classes) in their respective schools as both pretest and post-test. On-the-spot assessment was made. Each question was marked on a total of 100, then a mean across the two questions found for each test.

Results

The results of data analysis are presented in the tables below

Table 1: *Pre-test, t-test Analysis of Difference in Acquisition of Science Process Skill between Experimental and Control Groups of Physics Students.*

Science Process Skill	Group	N	$\overline{X}$ (%)	SD	Df	t	Decision at P< 0.05
Cognitive	Experimental	200	11.00	3.1	380	1.70 (1.96)	NS
	Control	200	10.50	2.8			
Observational	Experimental	200	13.00	2.5	380	1.77 (1.96)	NS
	Control	200	12.60	2.0			
Manipulation	Experimental	200	14.60	2.6	380	1.90 (1.96)	NS
	Control	200	15.06	2.1			
Computational	Experimental	200	14.47	3.0	380	1.94 (1.96)	NS
	Control	200	14.00	2.7			
Communicative	Experimental	200	15.70	1.8	380	1.58 (1.96)	NS
	Control	200	16.00	2.0			

t-value in bracket is critical value; NS = not significant at p < 0.05

Table 2: *Post-test, Analysis of Difference in Acquisition of Science Process Skills between Experimental and Control Groups of Physics Students.*

Science Process Skill	Group	N	$\overline{X}$ (%)	SD	Df	t	Decision at P< 0.05
Cognitive	Experimental	200	54.7	4.1	380	1.77 (1.96)	NS
	Control	200	54.0	3.8			
Observational	Experimental	200	58.0	2.7	380	24.27 (1.96) 2	S
	Control	200	50.0	3.8			
Manipulation	Experimental	200	60.0	1.9	380	27.73 (1.96)	S
	Control	200	54.0	2.4			
Computational	Experimental	200	62.0	3.1	380	16.93 (1.96)	S
	Control	200	57.0	2.8			
Communicative	Experimental	200	55.0	2.0	380	17.25 (1.96)	S
	Control	200	51.0	2.6			

t-value in bracket is critical value; NS = not significant at p < 0.05; S = Significant at p < 0.05

Discussion of Findings

The analysis in Table 1 shows that in the pretest, the critical t-value, 1.96 is greater than the calculated t-values 1.70, 1.77, 1.90, 1.94 and 1.59 for cognitive, observational, manipulative, computational and communicative skills, respectively. This shows that there was no significant difference in the performance of the two groups of physics students. In other words, the experimental and control groups were at the same level of acquisition of the science process skills during the pretest.

The analysis in Table 2 shows that in the post test, at 0.05 level of significance, the critical t-value, 1.96, is less than the calculated t-values: 24.27, 27.73, 16.93 and 17.25 for observational, manipulative, computational and communicative skills respectively. This shows a significant difference in acquisition of the respective science process skills in favour of the experimental group with higher mean percentage values. This implies that physics students taught by teachers exposed to process-based refresher course acquire the respective science process skills significantly higher than their counterparts taught by teachers who are not so exposed. This show-cases the efficacy of refresher courses in raising the capability of teachers to impact science process skills to students. This findings is consistent with that of Zeitler (1981) and Strawitz and Harlen (1987) which showed that the training of pre-service and inservice teachers in process based learning engender increased level of teacher effectiveness in implementing process-based learning.

Further, Table 2 reveals no significant difference in acquisition of cognitive science process skills between experimental and control groups of students, as the calculated t-value (1.77) is less than the critical t-value (1.96) at 0.05 level of significance. The slight higher mean percentage value for the experimental group implies that physics students taught by teachers exposed to process-based refresher course acquire cognitive science process skills marginally higher than their counterparts taught by teachers who are not so exposed. The marginal difference in acquisition of cognitive science process skill between the experimental and control groups of students implies a strong need for a more focused attention on the capacity-building of physics teachers, through inservice training and retraining programmes, in the area of cognitive science process skill. The level of acquisition of skills by students is limited to the teachers' professional training and competence. Lending credence to this fact, Olorukoba (2007) asserted that,

> *Our science teachers should be given opportunity for inservice training to improve upon their professional expertise…. Even the so called trained science teachers need to refresh themselves in order to be current of new and better methods of teaching different topics in their subject areas (p.5).*

Conclusion

Based on the findings of the study, the following conclusions are drawn:

1. Physics students who are taught process-oriented physics lesson by physics teachers who are exposed to process-based refresher courses acquire observational, manipulative, computational and communicative science process skills, significantly higher than their counterparts who received the lesson from teachers who are not so exposed.
2. physics students who are taught process-oriented physics lesson by physics teachers who are exposed to process-based refresher courses acquire cognitive science process skills marginally higher than their counterparts who received the lessons from teachers who are not so exposed.

Educational Implications and Recommendations

The superiority in the acquisition of science process skills (cognitive, observational, manipulative, computational and communicative skills) by students taught by process-trained teachers over those taught by non-process-trained teachers highlights an important issue: the teaching of processes of science in schools should be emphasized. This task is demanding. First, it calls for patience, experience and expertise from the teacher. Secondly, it demands a cultivation of scientific attitudes, some of which are: curiosity, open-mindedness, empiricism, skepticism and parsimony. These qualities do not come by chance. They come by constantly training and retraining of teachers. Teachers do not impact to students what they themselves are deficient in. Teachers at all levels of educational structure should, therefore, be trained and retrained accordingly.

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