

Original Research Article

Effects of a Training Programme in Hands-On Science on Pre-Service Teachers' Classroom Practice and Students Achievement in Chemistry

Dr. Olatunbosun Segun M.

Abstract

Department of Curriculum Studies,
Ekiti State University, Ado-Ekiti
Tel: 08039667581

E-mail: smolatfrank@gmail.com

The study sought to investigate the effects of a training programme in Hands-on science on pre-service teachers' classroom practice and pupils achievement in Chemistry. The study adopted a pre-test, post-test and control group quasi-experimental design. The population consisted of all Chemistry Education students of Ekiti State University, Ado-Ekiti. The sample was made up all 14 Chemistry Education students at 300 level. The subjects were grouped into high and low abilities based on their Grade Point Average (GPA) in the B.Sc. Ed course. Four instruments were used and these are chemistry Achievement Test (CAT) ($r=0.81$) Questionnaire on Pre-service Teachers' Knowledge of Hands-on ($r=0.76$) classroom observational schedule and course outline on Hands-on. Five hypotheses were generated and were all tested at 0.05 level of significance. The study revealed that there is an improvement on the pre-service knowledge of Hands-on approach after the training programme. The study also showed that the pre-service teachers exposed to Hands-on approach engaged students in class more than those not exposed. The findings also revealed that students taught using Hands-on approach performed better than those taught using conventional lecture method. It is therefore recommended that Hands-on approach should be used to teach Chemistry in schools for effective teaching-learning situation.

Keywords: Hands-on, lecture method, pre-service teachers, academic ability, achievement, training programme.

INTRODUCTION

As many countries of the world are pursuing the goal of excelling in science achievement among students, many are advocating instructional approaches that emphasizes activities and learning by doing. Many scholars that are pushing for reform of science teaching are of the opinion that young people can learn most readily about things that are tangible and directly accessible to their senses. Not only this, they grow in their ability to understand abstract concepts, manipulate symbols, reason logically and generalize (Rutherford and Ahlgren, 1990).

Students are likely to learn faster if the objects being

interacted with make meaning to them. Research finding according to National Science Board (1991), indicate that students are likely to begin to understand the natural world if they work directly with natural phenomena, using their senses to observe and using instruments to extend the power of their senses. Accordingly, instructional approaches that involve activity and direct experiences with natural phenomena have become collectively known as hands-on.

A great deal of benefits has been credited to Hands-on approach to teaching science. Students in a Hands-on

science programme will remember the material better, feel a sense of accomplishment when the task is completed, and be able to transfer that experience easily to other learning situations. Hands-on tends to stimulate students who are not as academically sound or do not show-interest in school, into participating and eventually absorbing information which they might not be able to get from the conventional methods.

By actually doing and experiencing science, students develop their critical thinking skills as well as discover scientific concepts. This discovery stays with students throughout their lifetimes while experience gained through memory and abstract thoughts fade away. Some school of thoughts are of the opinion that Hands-on forces students thinking by requiring interpretation of the observed events, rather than memorization of correct responses. Hands-on reduces dependence upon authority. Practical experiences in generating hypotheses and planning experiments will make the students to be more independent later in life. Therefore, the justification for Hands-on learning is that it allows students to build understanding that is functional and to develop the ability to inquire themselves, in other words, to become independent learners (David L. Naury and Peter Riller O, 1994).

Hands-on approach is hinged on Piaget's and Bruner's theories of learning. Piaget mandates that the learning environment should be rich in physical experiences. He opined that involvement is the key to intellectual developments and for the elementary school child, this includes direct physical manipulation of objects (McAnarney, 1978). On his own part, Bruner also stressed learning by doing. Bruner (1983) points out that the principal emphasis in education should be placed on skills – skills in handling, in seeing and imaging, and in symbolic operations, and this is the hallmark of Hands-on learning.

On the basis of this, the study sought to investigate the effects of Hands-on science programme on pre-service teachers' classroom practice and students' achievement in Chemistry.

Statement of the Problem

Most Nigerian students perceive science subjects as very difficult to learn. Most of them even consider Chemistry in particular as being 'volatile'. This informs why there is low enrolment in science class when compared with other subjects. The phobia arises as a result of the way science teachers handle the teaching of science. Science is being taught mostly in the absence of relevant equipment. Where the equipment are available, the approach being used is not stimulating to the learners. It is for this reason that the study sought to investigate the use of Hands-on approach to teaching Chemistry.

Research questions

1. Will the pre-service teachers' knowledge of Hands-on increase when exposed to a training programme in Hands-on?
2. Will there be any difference in the classroom practice of pre-service teachers trained in the use of the Hands-on approach and those not trained?
3. Will there be any difference in the classroom teachers of high and low academic abilities exposed to a training programme in Hands-on?
4. Will there be any difference in achievement in Chemistry of students who were taught using Hands-on and those taught by conventional lecture method?
5. Will there be any difference in the engagement rates of students taught using Hands-on and those taught using conventional method?

The following hypotheses were generated and tested at $P < 0.05$ level of significance:

Ho₁: There is no significant difference in the pre- and post-training knowledge of Hands-on scores of teachers exposed to the Hands-on training programme.

Ho₂: There is no significant difference in the classroom practice of teachers exposed to training in Hands-on and those not exposed.

Ho₃: There is no significant difference in the classroom practice of teachers of high and low academic abilities exposed to a training programme in Hands-on.

Ho₄: There is no significant difference in the achievement in Chemistry of students taught using Hands-on and those taught using conventional lecture method.

Ho₅: There is no significant difference in the engagement rates of students taught using Hands-on and those taught using conventional method.

Significance of the study

The study would enable science teachers across the globe to put across scientific knowledge to their students in a more practical and interesting way. The study would also be a channel for improving upon the low enrolment in the sciences. Furthermore, the study would serve as efforts by Nigerian educators to jettison the age-long practices of rote-learning, memorization and teacher-centred strategies. Not only would these, the study also encourage the policy makers to advise the government to provide scientific equipment to schools.

METHODOLOGY

The study adopted a pre-test, post-test control group quasi-experimental design. The design made use of a 2x2 factorial matrix shown below in Table 1.

Table 1. The Factorial Matrix of the Design

Academic Ability	Instructional Strategies	
	Hands-on	Conventional
High		
Low		

Variables in the Study

A. Independents Variables

- (i) Hands-on training programme
- (ii) Hands-on learning approach
- (iii) Conventional lecture method

B. Dependent Variables

- (i) Teachers' classroom practice
- (ii) Students achievement in Chemistry

C. Moderator Variables

Teachers' Academic Ability at two levels

- (i) High (ii) Low

Selection of subjects

All part 3 Chemistry Education students of Ekiti State University, Ado-Ekiti were used for the study. These were 14 in number and were grouped according to their ability level based on their Grade Point Average (GPA) in the B.Sc. (Ed) course. Four (4) high academic ability student teachers and three (3) low academic ability student teachers were selected for each of the experimental and control groups. Subjects with GPA less than 2.5 are regarded as low academic ability while those with GPA 2.5 and above are regarded as high academic ability.

Seven (7) public senior secondary schools in Ado Local Government of Ekiti State, which are normally being used for teaching practice were purposively selected. These schools have qualified Chemistry teachers and have been presenting candidates for Senior School Certificate Examination (SSCE) for some years past. Also, the schools have not covered part or all of the topics considered in the study. Fourteen (14) classes were purposively selected and assigned to the pre-service teachers. Twenty (20) SS2 students were randomly selected in each class making a total of 280 students used in the study.

Instruments

Four instruments were used for the study. These were

1. Chemistry Achievement Test (CAT) ($r=0.81$)
2. Questionnaire on Preservice Teachers' Knowledge. ($r=0.79$)
3. Classroom observational schedule
4. Course outline on Hands-on approach.

Research procedure

The subjects (the pre-service teachers) were trained for 2 weeks in Hands-on science programme. At the commencement of the training a questionnaire on pre-service teachers' Hands-on related knowledge was administered on all the subjects of the experimental group as a pre-test. This was followed by demonstration lessons on the use of Hands-on approach to teach students. They were taken through many activities on how to assemble equipment for Hands-on and how to prepare lesson plans to demonstrate the acquisition of Hands-on skills and how to teach each of the selected concepts.

Practice sessions were undertaken with the trainees to fine-tune what they have learned during demonstrations. They had the opportunities to practice and to be corrected where lapses existed.

A post-test was conducted using the same test used at the beginning of the training. The classroom practice then followed. This lasted for 6 weeks.

The pre-service teachers administered the Chemistry Achievement Test (CAT) on the students of both experimental and control groups as pre-test. The two groups were then taught the selected topics. The experimental group was taught, using Hands-on approach while those of the control group were taught using conventional lecture method, all with well prepared notes. At the end of the teaching session, CAT was re-administered as post-test. Data collected were analyzed.

RESULTS

The summary of the results are hereby presented in the following tables

H_{01} : There is no significant difference in the pre-and post-training knowledge of Hands-on training programme.

Table 2 presents the t-test comparison of the mean scores of the teachers' pre and post-training knowledge of Hands-on.

The table shows that the subjects scored higher in the post-test than in pre-test. The difference is significant ($t = 245$, $df = 6.6$ $P < .05$) To this effect, hypothesis 1 is rejected.

H_{02} : There is no significant main effect on teachers' classroom practice.

Table 3 shows that subjects exposed to Hands-on training programme had a mean score of 19.83 while

Table 2. T-test comparison of the mean scores of the teachers' pre and post-training knowledge of Hands-on

Achievement	N	\bar{x}	SD	df	t	Sig.
Pre-test knowledge	7	6.3	0.75			
Post-test knowledge	7	8.47	1.17	6.6	2.45	.000*

*Significance at P <.05

Table 3. T-test comparison of classroom practices of pre-service teachers exposed to Hands-on programme and those not exposed.

Group	N	\bar{x}	SD	df	t	Sig.
Hands-on	7	19.83	3.24			
Lecture Method	7	6.20	1.60	13.26	6.01	.000*

*Significance at P <.05

Table 4. T-test comparison of classroom practices of pre-service teachers with high and low academic abilities.

Teachers' Academic Ability	N	\bar{x}	SD	df	t	Sig.
High	4	23.68	2.16			
Low	3	15.96	2.71	6.26	1.33	.002*

*Significance at P <.05

Table 5. Describes the t-test comparison of achievement scores of students taught by high and low academic ability teachers in the experimental and control groups.

Achievement		N	\bar{x}	SD	df	t	Sig.
Experimental	High	80	9.58	2.33			
	Low	60	7.32	2.08	1.18	1.35	.001
Control	High	80	7.15	2.17			
	Low	60	5.82	1.55	.579	2.63	*.000

*Significance at P <.05

Table 6. Engagement rates of subjects taught in the experimental and control groups.

	5 min	10 min	15 min	20 min	25 min	30 min	35 min	40 min
Subjects taught by experimental group	55.8%	56.9%	54.0%	52.5%	52.7%	55.4%	53.0%	49.8%
Subjects taught in the control group	48.2%	46.1%	49.3%	48.1%	48.1%	49.7%	48.1%	48.1%

those not exposed had a mean score of 6.20. This difference in classroom practice scores is found to be significant ($t = 6.01$, $df = 13.26$; $P < .05$). Therefore hypothesis 2 is rejected.

H_{03} : There is no significant main effect of academic ability on pre-service teachers. Table 4 presents the result.

Table 4 shows that high ability pre-service teachers score higher ($\bar{x} = 23.68$) than low ability pre-service teachers. This is found to be significant ($t = 1.33$, $df = 6.26$; $P < .05$). Based on this, hypothesis 3 is rejected.

H_{04} : There is no significant difference in the mean

achievement scores of Chemistry students taught by high and low ability teachers using Hands-on and conventional lecture methods.

From table 5, it is observed that students in the experimental group performed better than their counterparts in the control group irrespective of the academic ability of the pre-service teachers. Hence, hypothesis 4 is rejected.

H_{05} : There is no significant difference in the engagement rates of students taught using Hands-on and those taught using conventional lecture method. The result is presented as shown in Table 6.

It is observed from the table that pupils taught by the pre-service teachers using Hands-on are better engaged than those taught by other teachers using conventional lecture method. This can be seen in the higher percent rates of the experimental group.

DISCUSSION

The results of the study indicate that there is a tremendous improvement on the pre-service knowledge of Hands-on approach after the training programme. This is in agreement with Penick and Yager (1993) who asserted that teacher efficiency improves using Hands-on approach in teaching. Their assertion is based on the premise that the amount of preparation time that the teachers using Hands-on approach to teach science is reduced. The results of the study also show that the pre-service teachers exposed to the training programme in Hands-on engaged students in class more than those not so exposed. This corroborates the findings of Rutherford, (1993) which stated that Hands-on and learning by experience are powerful ideas and that engaging students actively and thoughtfully in their studies pays off in better learning. Not only these, the results also revealed that there was a significant difference in the achievement scores in Chemistry of subjects taught by the Hands-on approach and those taught by the conventional lecture method. Those taught by the Hands-on approach performed better than those taught by conventional lecture method. The Hands-on approach enhances learning by increasing skill proficiency in processes of science, especially laboratory skills and specific science process skills, such as graphing and interpreting data. (Mattheis and Nakayama, 1988).

RECOMMENDATIONS

On the basis of the findings, it is recommended that:

New instructional strategies such as Hands-on should be employed in secondary schools to enhance the

learning experiences of the science students generally and chemistry students in particular.

The teacher-training programme should include Hands-on to effectively use the method in future when the pre-service teachers become full fledged teachers as a way of enhancing students' achievement in Chemistry.

The teachers already on the field should be trained to have the knowledge of the Hands-on approach through organized seminars, workshops and conferences to expose them to the essential features of the approach to improve their classroom practices and enhance students achievement.

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