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EFFECTS OF TEACHER YEAR OF EXPERIENCE ON THE USE OF INNOVATIVE INSTRUCTIONAL APPROACH IN CHEMISTRY INSTRUCTION: A CASE STUDY OF SCIENCE- TECHNOLOGY-SOCIETY INSTRUCTIONAL APPROACH

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Abstract
This study investigated the effects of different levels of teacher year of experience on the use of innovative instructional approach in Chemistry instruction. The study was conducted using SS2 Chemistry students in Ogidi Education zone of Anambra state, Nigeria. The study adopted a quasi experimental design of the pretest posttest non equivalent control group design. Two research questions and two hypotheses guided the study. Three hundred and ten Chemistry students from randomly sampled twelve public secondary schools and their twelve teachers were used for the study. Six schools were randomly assigned to the treatment group while the remaining six were assigned to the control group. The treatment group was taught organic Chemistry using Science-technology-society instructional approach while the control group was taught the same topic using the conventional instructional approach. Validated Chemistry Achievement Test (CAT) was used to collect data for the study. The CAT had reliability index of 0.97. The mean score and standard deviation were used to answer the research questions while analysis of variance (ANCOVA) was used to test the hypotheses at 0.05 level of confidence. The study reveals that there is significant difference in the use of innovative instructional approach in Chemistry instruction among teachers with different levels of year of experience as shown by the students' achievement. Again, there is significant interaction effect between teacher year of experience and the use of innovative instructional approach in Chemistry instruction. From the findings of the study, it was among other things recommended that School owners and professional bodies such as Science Teachers Association of Nigeria and Ministry of Education should organize conferences, seminars and workshops for cross fertilization of experiences and ideas among Chemistry teachers with different levels of year of experience.

Key words: Teacher year of experience, innovative instructional approach, Science-Technology-Society instructional approach.

Introduction

The importance of Chemistry for nation building cannot be over emphasized. As a key science subject, Chemistry serves as a hub for technology and industrial development in the society. Considering the indisputable importance of Chemistry in nation building and development, Nigerian government for instance has rightly included Chemistry in the Senior Secondary School (SSS) curriculum as a core science subject (Igboanugo, 2018).

However, despite the realization of the importance of Chemistry, it is disturbing that students achieve poorly in the senior secondary school Chemistry. This is shown by results of external examinations like Senior School Certificate Examination (SSCE) and General Certificate in Education (GCE). Reports by researchers (Igboanugo & Njoku, 2015; Nnoli, 2015) and West African Examination Council (WAEC) chief examiners report (2013-2016) show a continuous poor achievement by students in senior secondary school Chemistry. The perennial poor academic achievement in Chemistry is alarming (Ashu & Ayadema, 2012). This might lead to the hydra-headed problems as found in Nigeria and most other third world countries. Such problems in Igboanugo, 2013 opinion include: inadequate number of students offering Chemistry oriented courses in tertiary educational institutions in Nigeria; poor economy, poor industrialization, lack of job, starvation, high maternal and infant mortality rate, spread of disease and sickness, environmental unfriendliness, and poor peaceful environment to mention but a few. Thus researchers such as Anugwo & Asogwa (2015) and Nnoli (2016) have identified some factors responsible for students' poor achievement in Chemistry to include: comprehension by students that Chemistry is difficult to learn; students' poor attitude; lack of qualified and experienced teachers; teachers' attitude and ineffective teaching method/ instructional approach.

Instructional approaches are systematic procedures employed by teachers in attempt to help learning take place. Instructional approaches shape the learning environment. As part of the lesson design, an effective Chemistry teacher selects a particular instructional approach or set of instructional approaches to engage students in learning (Akani, 2013).The conventional instructional approaches adopted by most Chemistry teachers have been identified to be the main cause of students' poor achievement and low interest in Chemistry (Igboanugo, 2013; Igboanugo & Njoku, 2015). This is because according to Ezenduka, Achufusi & Okoli (2014), the conventional instructional approach is without hands-on or practical activity and lacks innovation. Thus, the conventional instructional approach does not relate the concepts/topics to the socio-cultural problems and issues of the student. The teacher using the conventional instructional approach has monopoly of the teaching-learning activities. The teacher assumes that all the students in the class have the same entry behaviour (Njoku, 2015). Students work individually and are assessed individually. Only the best students are rewarded and this forces students to work against each other so as to be the best (Ogbonne & Offorma, 2013). For a Chemistry lesson to be fruitful, Egolum and Igboanugo (2017) aver that students should be actively involved. In contrary, the conventional instructional approach often used by Chemistry teachers reduces students to mere passive listeners with little or no interest and gives room for misconception (Nicoll, 2011). Students perceive Chemistry

concepts and topics to be difficult and abstract due to the ineffective conventional instructional approach (Aniodoh & Eze, 2014).

Researchers affirm that most Chemistry concepts and topics are abstract and difficult to the students (Aniodoh & Eze, 2014; Njoku, 2015). This demands adoption of the innovative student-centred instructional approaches that cannot only ignite and hold the interest of the students, but permeate the abstract concepts and topics for easy understanding and improved academic achievement (Igboanugo, 2011). The innovative instructional approaches according to Nnaka, 2006 are the ideas/strategies that efficaciously accomplish the goals of teaching sciences. They include: application of advance organizers, cooperative learning, generative learning, concept mapping, learning cycle, simulation and games, active learning process and science-society-instructional approach.

Science-Technology-Society (STS) instructional approach is an approach in teaching and learning Science in general and Chemistry in particular. According to Mansour (2007) Science-Technology-Society (STS) instructional approach makes traditional concepts and processes found in typical science and social studies programmes more appropriate and relevant to the students. Science-Technology-Society instructional approach according to Njoku (2009) starts instruction from the real world problems included in the students' perspective, instead of starting with the basic concepts and processes as included in the existing curriculum. Thus, STS instructional approach is a mode of instruction that focuses on teaching and learning of Chemistry from the student's perspective of the real-life problems and processes which have Chemistry and technology components (Igboanugo 2018).

Though the Science-Technology-Society instructional approach and other innovative approaches have been found to be effective in teaching Chemistry (Igboanugo, 2019), none goes without weaknesses (Ojokoku, 2015; Akpoghol, Ezeudu, Adzape & Otor, 2016). In agreement with this, Egolum and Igboegwu (2013); Akpoghol, Ezeudu, Adzape & Otor (2016) observe perennial poor students' achievement and low interest in Senior Secondary School Chemistry even after several researches on how to improve students' achievement and interest in Chemistry using innovative instructional approaches. This demands further investigation into adoption and application of the innovative instructional approaches by teachers for more effective teaching-learning process in Chemistry.

The teacher is an agent in Chemistry curriculum implementation process . Coelho (2007:37) answering question about who is a teacher says: "a teacher isn't someone who teaches something, but someone who inspires a learner to give his/her best in order to discover what he or she already knows." The teacher is the prime factor in the teaching and learning process (Rice, 2010). In a teaching situation, a complex interaction pattern exists among teachers, learners and materials. Effective Chemistry teacher must excel in management of the complex interactive patterns and in the understanding of the types of learners confronting the teachers during instruction. It then follows that the Chemistry teacher must be dynamic and resourceful to use his/her professional prowess to manage the learner and materials for effective teaching and learning of Chemistry.

The Chemistry teacher remains the most vital determinant of the quality of Chemistry education offered in the school system. In line with this, Ugwuanyi & Enogu (2013), contend that the onus of adequate and effective Chemistry curriculum implementation is on the teacher. The prior and continuous preparation of the Chemistry teacher that will handle the curriculum is therefore a vital issue. This is because according to Fwangshak & Laraba (2015) even where what and how to teach are recommended, the quality of teaching or otherwise is determined by the teacher. It therefore follows that the teacher's fit in terms of knowledge, year of experience and readiness is important in the Chemistry teaching and learning process.

The teacher is the mediator and coordinator of the learning process, the facilitator of learning of skills, and the assessor of the entire educational development of learners. Thus, Olaleye (2011) establishes that there is relationship between teacher characteristics and learners' achievement. The teacher characteristics found to be dominant in various country studies are related to; qualification, experience, attitude and personality (Gravestock & Gregor-Greenleaf 2008). For a Chemistry teacher to transmit knowledge, skills and attitudes to students effectively he/she must possess the requisite skills which is the ability to do something well as a result of training (Ifeanyieze & Olaitan, 2010). Such requisite skills required of the Chemistry teacher for pedagogical activities might be gathered from both training and experience. Teachers who have spent more time studying and teaching are likely to develop higher order skills for meeting the needs of diverse learners in the class. This is in line with Abuseji (2007) who reported that Chemistry teacher's year of experience has significant effect on students' achievement in Chemistry. In contribution, Kosgei, Mise, Odera & Ayugi (2013) assert that more experienced teachers are considered to be more able to concentrate on the most appropriate way to teach particular topics to students who differ in their abilities, prior knowledge and backgrounds.

The Chemistry teacher year of experience according to Load & Sorensen (2014) is important in selecting appropriate learning experiences and effective instructional approaches for improving achievement in Chemistry. However, Njelita (2015) reported that most Chemistry teachers do not use the effective innovative instructional approach during instruction probably because they are unaware of the innovative approaches. Again, lack of necessary skills required in using the effective innovative instructional approaches by the Chemistry teachers might debar them from using the innovative instructional approaches during Chemistry instruction.

Since adoption and adequate use of the innovative instructional approaches by the teacher is the key factor in facilitating and promoting learning in Chemistry, the important question to answer might be, to what extent does teacher year of experience determine the effective use of the innovative instructional approaches in Chemistry instruction? Answer to such question might help to encourage adequately the in-serving Chemistry teachers in using the effective innovative instructional approaches in Chemistry instruction. Thus, empirical investigation into the effects of teacher year of experience on the use of innovative instructional approach in Chemistry instruction using Science-Technology-Society instructional approach as a case study could be curious.

Purpose of the study

The purpose of this study is to determine the effects of different levels of teacher year of experience on the use of innovative instructional approach in Chemistry instruction. In specific terms this study is meant to determine:

(i)The effect of teacher of year of experience on use of innovative instructional approach in Chemistry instruction

(ii)The interaction effect of teacher year of experience and innovative instructional approach in Chemistry instruction

Scope of the Study

This study was carried out in Ogidi Education zone of Anambra state, South-East of Nigeria. Students' achievement in Chemistry in this area has been observed by the researcher to be poor. The content area used is organic Chemistry which is one of the content areas perceived difficult by students (WAEC, 2015). Senior Secondary School 2 Chemistry students and their teachers were used for the study. The mode of instruction used was the Science-Technology-Society instructional approach. Science-Technology-Society instructional approach was used for the study because as an innovative instructional approach, Science-Technology-Society instructional approach has been found to be effective in improving students' achievement in Chemistry. Again, the instructional approach relates teaching and learning Chemistry to the society and technology which is necessary for national development (Igboanugo, 2018).

Research Question

The study was guided by the following research questions:

(1)What are the achievement mean scores of students taught Chemistry by teachers with different levels of year of experience using innovative instructional approach?

(2) What is the interaction effect between teacher year of experience and innovative instructional approach on students' achievement mean score in Chemistry?

Hypothesis

The following null hypotheses were formulated and tested at an alpha level of 0.05:

HO_1: There is no significant difference between the achievements of students taught Chemistry by teachers with different levels of year of experience using innovative instructional approach.

HO_2: There is no significant interaction effect between teacher year of experience and innovative instructional approach on students' achievement in Chemistry.

Methodology

The quasi experimental design was adopted for this study. Specifically the pretest post-test nonequivalent control group design was used for the study. The design is represented thus:

O_b X O_a

O_b ~ X O_a

X = Treatment (STS instructional approach)

~X = Control (Conventional instructional approach)
O_b = Pretest measurement
O_a = Post-test measurement
---------- Indication that treatment and control groups are not got by random assignment of subjects to conditions.

Population of the Study

The population of the study comprised of all SS2 students in Ogidi Education zone of Anambra state, Nigeria. A sample of 316 SS2 Chemistry students from twelve secondary schools and their twelve regular Chemistry teachers was used in the study. The schools were drawn from the fourty schools of the zone by simple random sampling. Treatment and control groups were assigned to the schools at random. Six schools were assigned to the treatment group and the remaining six schools assigned to the control group. The twelve Chemistry teachers were classified for the purpose of this work into low experience, medium experience and high experience as shown below:

0-4years (Low experience), 5 teachers
5-9 years (Medium experience), 3 teachers
10 years and above (High experience), 4 teachers.

Instrument for Data Collection

The Chemistry Achievement Test (CAT) was the instrument used for data collection in this study. The instrument comprised of two sections, sections A and B. Section A sought for personal data of the student while section B comprised of instructions and the items with their options.

The CAT is a 35-item, 4-option multiple choice objective test covering organic Chemistry as recommended in the SSII Chemistry curriculum (FME, 2007). A test blue print was used to ensure content coverage of the topic taught in the course of the study in the instrument. The options were lettered a, b, c, d with one option being the correct response while others are distracters.

The instrument was face validated by experts in Chemistry education, Educational Measurement and Evaluation and secondary school teachers to ensure that each of the test items was understandable and relevant to SS2 students who constituted the sample for the study. The instrument was trial tested on 33 SS2 students of a secondary school outside the zone of study. The trial test helped to improve the quality of the test items, estimate the time it might take for an average student to effectively complete the test and confirm the face validity of the items. Again from the result of the trial test, reliability index of the instrument was determined. Using Kuder-Richardson formular 20 internal consistency of CAT was found to be 0.97, indicating that the items were consistent on cognitive learning of the topic of interest to this study.

Experimental Procedure

Two instructional approaches were used for the study. Science-technology-society instructional approach was used in teaching the treatment group while the conventional instructional approach was used in teaching the control group. The regular Chemistry

teachers were used in this study to teach their respective regular classes. This arrangement has advantage of removing the hawthorn effect which might occur when a strange teacher teaches the students. The teachers in the treatment group were trained for three weeks to conform to the STS instructional approach lesson plan strictly as prepared by the researchers. In the control group, the regular teachers taught their respective schools using the usual conventional instructional approach. The same topic, organic Chemistry was taught in both the treatment group and control group. A pretest was administered to the subjects using the validated CAT, marked and recorded by the researchers before the experiment commenced. The experiment was carried out during normal school hours using the school time table for the classes. The experiment lasted for five weeks. On the last day of the experiment, a post-test was administered to the subjects using the validated CAT, marked and recorded by the researchers. The CAT used in the post-test was the same in content with the CAT used in the pretest but differed in the sequence of items.

The data collected from the pretest and post-test were used to answer the research questions and test the hypotheses for the study. The research questions were answered using mean and standard deviation of the achievement scores. The hypotheses were tested using Analysis of Covariance (ANCOVA).

Results

Research Question1

What are the achievement mean scores of students taught Chemistry by teachers with different levels of year of experience using innovative instructional approach?

Table 1: Mean and standard deviation of students' achievement scores in Chemistry by teachers with different year of experience

Groups	Teacher Experience	Pretest		Post-test		Gain mean score	Number of subjects
		Mean	Std Dev	Mean	Std Dev		
Treatment (STS)	Low	25.26	11.33	66.38	16.18	41.12	47
	Medium	23.23	10.98	83.89	10.74	60.66	57
	High	26.30	11.12	75.42	13.42	49.12	53
Control (Conventional)	Low	29.85	11.13	37.83	17.87	7.98	54
	Medium	34.74	9.15	40.88	20.83	6.14	42
	High	31.42	11.05	46.21	11.47	14.79	57

The result presented in Table 1 shows that the gain mean scores in the treatment group were 41.14, 60.66 and 49.12 for students taught by low experience teachers, medium experience teachers and high experience teachers respectively. Thus Chemistry students taught by the medium experience teachers had the highest gain mean score followed by those taught by high experience teachers while the Chemistry students taught by low experience teachers had the least gain mean score. The difference in the standard deviation indicates variations in clustering of the scores around the mean scores of each group.

The gain mean scores in the control group were 7.98, 6.14 and 14.79 for Chemistry students taught by low experience teachers, medium experience teachers and high experience teachers respectively. Thus Chemistry students taught by high experience teachers had the highest gain mean score followed by those taught by low experience teachers while the Chemistry students taught by medium experience teachers had the least gain mean score.

The result shows that there is difference in the achievement of students taught Chemistry by low, medium and high experience teachers. Hypothesis one tested at $p< 0.05$ alpha level was used to establish whether the difference was significant or not.

Research Question 2

What is the interaction effect between teacher year of experience and innovative instructional approach on students' achievement mean score in Chemistry?

As shown in Table 1, students taught by the medium experience teachers using the science-technology-society instructional approach have the highest gain mean score whereas students taught by high experience teachers using conventional instructional approach have the highest gain mean score. This implies that there is interaction between teacher year of experience and instructional approach on students' achievement in Chemistry. Hypothesis two tested at $p< 0.05$ alpha level was used to establish whether the interaction was significant or not.

Hypotheses

HO_1: There is no significant difference between the achievements of students taught Chemistry by teachers with different levels of year of experience using innovative instructional approach.

Table 2: Summary of Analysis of covariance (ANCOVA) of effect of teacher experience on students' achievement in Chemistry

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	97674.270[a]	6	16279.045	71.432	.000
Intercept	153677.044	1	153677.044	674.331	.000
Pretest Achievement	990.397	1	990.397	4.346	.038
Method	71196.267	1	71196.267	312.408	.000
Teacher Experience	6058.972	2	3029.486	13.293	.000
Method * Teacher Experience	2349.406	2	1174.703	5.155	.006
Error	69052.324	303	227.895		
Total	1239474.000	310			
Corrected Total	166726.594	309			

Result of the analysis in Table 2 shows that the exact probability value of 0.000 associated with teacher experience is less than 0.05 level of significance; (F (2, 303) = 13.293, P=0.000). Thus, HO_1 is rejected. The decision therefore, is that there is significant difference between the achievements of students taught Chemistry by teachers with different levels of year of experience using innovative instructional approach. However, the direction of the observed difference among the achievement with teacher year of experience is determined with a post-hoc test on Table 3 below. The post hoc analysis shows that students taught by medium experience teachers achieved significantly higher than students taught by low experience teachers, p=0.000. Also, students taught by high experience teachers achieved significantly higher than students taught by low experience teachers, p=0.000. However, students taught by medium experience teachers did not achieve significantly higher than students taught by higher experience teachers, p=0.603.

Table 3: Post Hoc on Students' Mean Achievement Scores by Teacher Experience

Dependent Variable:PosttestAch

(I) TeacherExperience	(J) TeacherExperience	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Low	Medium	-10.017*	2.153	.000	-14.254	-5.780
	High	-8.922*	2.086	.000	-13.027	-4.816
Medium	Low	10.017*	2.153	.000	5.780	14.254
	High	1.095	2.105	.603	-3.047	5.237
High	Low	8.922*	2.086	.000	4.816	13.027
	Medium	-1.095	2.105	.603	-5.237	3.047

HO_2: There is no significant interaction effect between teacher year of experience and innovative instructional approach on students' achievement in Chemistry.

Table 2 indicates that the exact probability value of .006 associated with interaction of method and teacher experience is less than 0.05 level of significance; (F (2, 303) = 5.155, P=0.006). Thus, HO_2 is rejected. The decision therefore, is that there is significant interaction effect between teacher year of experience and innovative instructional approach on students' achievement in Chemistry.

Discussion of Findings

The results of this study show that the effective use of innovative instructional approach to improve on students' achievement in Chemistry is determined by teachers' year of experience. This finding is consistent with Abuseji (2007); Kosgei, Mise, Odera & Ayugi (2013); Load & Sorensen (2014) who reported significant relationship between teacher experience and students' achievement. Students taught Chemistry using innovative instructional approach by medium experience teachers had highest achievement mean score followed by those taught by high experience teachers while students taught Chemistry using innovative instructional approach by low experience teachers had the least mean achievement score. Also the finding that students taught by medium experience teachers had high mean score is in consonance with Kosgei, Mise, Odera & Ayugi (2013) who reported that teachers with experience above three years recorded higher academic achievement. The unexpected drop in the mean achievement score of students taught by high experience teachers could be as a result of administrative work being engaged by the high experience teachers. At high year of experience, most Chemistry teachers combine such administrative functions as deans of studies, vice principals, teacher disciplinarians with classroom teaching which would not offer them enough time to pay maximum attention to teaching. The results also showed the interaction effect of teacher experience and innovative instructional approach on students' achievement in Chemistry is significant. This result implies that effective use of instructional approach would depend on the teacher year of experience. The education implication is that the skills and readiness required for effective use of innovative instructional approaches in teaching and learning Chemistry increases with increase in teachers' year of experience. Thus, regular training of the in-serving Chemistry teachers on the use of innovative instructional approaches might be necessary.

Recommendations

From the findings of this study, the following recommendations are made toward possible improvement in teaching and learning Chemistry.

1) School owners and professional bodies such as Science Teachers Association of Nigeria and Ministry of Education should organize conferences, seminars and workshops for cross fertilization of experiences and ideas among Chemistry teachers with different levels of year of experience

2) Regular training of in- service Chemistry teachers should be organized by the stake holders to increase their experiences in the use of adequate instructional approaches

3) School owners should find out strategies such using adequate fringe benefits to retain experience Chemistry teachers in schools

4) Team teaching should be encouraged among Chemistry teachers where teachers would teach Chemistry topics and concepts based on teachers' experiences.

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