

MODIFYING CLASSROOM INSTRUCTIONAL STRATEGIES TO IMPROVE SECONDARY SCHOOL STUDENTS' LEARNING OUTCOMES IN CHEMISTRY IN OSUN STATE, NIGERIA

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Abstract

The paper examined the effects of Heuristic, Associative Creativity and Community Contact Instructional Techniques in improving students' performance and attitude in Chemistry among secondary school students. The study adopted the non-equivalent pretest-posttest control group research design. The population comprised all Senior Secondary (SS) II Chemistry students in Osun State. The sample comprised 200 SS II Chemistry students in their intact classes from four schools selected using multi-stage sampling technique. One intact class of SS II students in each school were selected using simple random sampling technique. The four schools were randomly assigned to three experimental and one control groups. The two instruments used: Students' Chemistry Achievement Test and Questionnaire on Attitude toward Chemistry had reliability coefficients of 0.82 and 0.84 respectively. Findings revealed that the three instructional strategies differentially improved students' performance ($F = 48.57$; $p < 0.05$) and attitude ($F = 15.54$; $p < 0.05$) better than the conventional teaching method with Community Contact Instructional Technique being the best.

Keywords: Heuristic, Associative Creativity, Community Contact, Instructional Techniques Performance, Attitude, and Chemistry.

Introduction

Science and Mathematics teaching and learning are very imperative for meaningful technological development in any country. The scientific and technological progress could be achieved if Chemistry is meaningfully taught at secondary school level in order to ensure continued interest of learners and promote their conceptual understanding in the subject since it could be regarded as central to all other science subjects. The knowledge of Chemistry is central to vocations in health services, pharmaceutical, petroleum and petrochemical industries, agriculture, food processing, teaching services and extractive industries. Learning Chemistry goes beyond only learning facts and concepts that describe the physical world at the atomic level, but also relating the Chemistry curriculum contents to day-to-day human activities. Chemistry promotes advancement in science and technology by

enabling critical thinking and problem solving which are essential ingredients in the disciplines. Ability to achieve this target is however dependent on the cumulative performance of students in school Chemistry. In south western Nigeria, achieving this cumulative performance and attitude in Chemistry has been problematic. Students are not learning as expected and attitude towards the subject is equally not impressive.

Following Nigeria's endorsement of international protocols for Education for All (EFA) and the Millennium Development Goals; and subsequent adoption of a National Economic Empowerment and Development Strategy (NEEDS), senior secondary school Chemistry curriculum objectives are designed to cater for contemporary needs of the nation as outlined in the Nigerian Educational Research and Development Council (NERDC, 2009) to enable students to:

- (i) develop interest in the subject of Chemistry;
- (ii) acquire basic theoretical and practical knowledge and skills;
- (iii) develop interest in science , technology and mathematics;
- (iv) apply skills to meet societal needs of creating employment and wealth; and
- (v) provide a course which is complete for students not proceeding to higher education while at the same time provides a reasonably adequate foundation for a post-secondary Chemistry course.

In order to achieve these objectives, factors identified from research studies as being responsible for students' unimpressive performance in Chemistry had to be addressed. The most common factors identified were the inappropriate, uninspiring, non-innovative teaching methods and strategies adopted by the teachers, inadequate exploration of the community where learners dwell to gain most of their learning experiences coupled with students' inability to relate Chemistry curriculum content to day-to-day human activities, (Bamidele, 2003; Adetunji, 2007, Olorundare and Aderogba, 2009). The researchers maintained that if novel teaching methods were employed in teaching the students, learners would perform better. According to Olorundare and Aderogba (2009) unless a teacher adopts suitable strategies, and engage students actively in the classroom, learners would continue to record unimpressive performance in Chemistry because students learn better when they are actively involved in the teaching and learning processes. Teachers must continue to organize instruction by using learner centered strategies that could facilitate learning.

In order to achieve the set goals of secondary school Chemistry curriculum objectives and facilitate meaningful learning, students are supposed to learn for their own sake through hands-on and minds-on meta-cognitive approaches. Memorization leads to regurgitation of facts, poor retention ability and non-transfer of knowledge all that served as evidence of lack of understanding thus, cannot promote thinking and

problem-solving skills to meet societal needs for creating employment and wealth. Observations by the researchers have discovered that in most of our secondary schools, the usual practice of most teachers is to give specific chemical reactions in learning Chemistry without explaining the principles behind them nor link it to everyday life applications. The students are not being exposed to intensive experimentation, inquiry-based and collaborative learning which will make them to be vast in Chemistry that can help them to understanding the principle involved in the various concepts in the subjects. The omnipresent challenge in teaching Chemistry in senior secondary schools is lack of proven methods of organizing instruction that will facilitate learning for majority of students. Heuristic, associative creativity and community contact instructional techniques which have not been sufficiently used in learning Chemistry may be a solution.

Heuristic Instructional Technique (HIT) is an approach in which students are given activities to develop knowledge and understanding of specific ideals by engaging in self-discovery through the use of definite route (procedural operations) while the teacher acts as facilitator. Fajemidagba and Olawoye (2009) described Heuristic Instructional Technique (HIT) as rules for selecting search paths through problem space by exploiting the information in the task environment. In HIT, the facilitator provides procedural knowledge of the process for learners to discover the path way by themselves through their experiences. The technique is based on thinking and discovery. HIT is based on four principles which are: principles of activity or learning by doing, law of exercise, logical thinking and purposeful experience. The students get an insight into what they are doing and develop a critical attitude and the like. HIT involves the teaching process of growth of the mind rather than on the storing of knowledge.

Associative Creativity Instructional Technique (ACIT) refers to a teaching approach of creative assemblages where students contribute ideas in order to generate fluent and novel ways of tackling scientific problems and organize materials through collaborative knowledge with peers. Craft, Jeffery and Leibling (2001) explained that, Associative Creativity Instructional Technique (ACIT) is a lateral thinking process by which students are encouraged to develop ideas on

issues in order to diagnose a problem. In ACIT, the facilitator keeps the session focused on the problem with no one criticizing the ideas generated by the students.

Oloyede, Ajibade and Bamidele (2010) explained that Community Contact Instructional Technique (CCIT) is a strategy used either to bring the community to the classroom or to take the class to the community. Taking the students out of the classroom and engaging them in utilization of resources in the community relevant to Chemistry classroom experience for the purpose of learning some concepts in Chemistry is the central core of the technique and has the similar feature as field trip. The focus for the CCIT is to enable the learners to see in reality what has been taught in theory and discover things by seeing, touching, feeling, smelling or even tasting.

Statement of the Problem

Chemistry attracts many students at the secondary school yet studies have shown that performance is not as good as expected. Unimpressive performance is attributed to poor thinking ability, inadequate problem-solving skills, inappropriate teaching methods by the teachers and lack of utilization of resources in the community. Instructional designs in most Chemistry classrooms may not have met learners' needs for conceptual understanding and promotion of the right attitude to learning probably due to conventional teaching method used. Heuristic, Associative Creativity and Community Contact Instructional techniques are learner centred strategies that have been effectively used to improve learning outcomes in technological subjects. The likelihood of these techniques promoting effective Chemistry teaching has not been ascertained in Nigeria.

Objectives of the Study

The specific objectives of the study are to:

- a. determine the effects of Heuristic Instructional Technique (HIT), Associative Creativity Instructional Technique (ACIT) and Community Contact Instructional Technique (CCIT) and Conventional Teaching Method (CTM) on performance of students in Organic Chemistry in Osun State;

- b. compare the attitude of students towards learning Organic Chemistry when exposed to HIT, ACIT and CCIT and CTM.

Research Hypotheses

From the objectives mentioned above, the following hypotheses were generated.

1. There is no significant effect of each of Heuristic Instructional Technique (HIT), Associative Creativity Instructional Technique (ACIT), Community Contact Instructional Technique (CCIT) and Conventional Teaching Method (CTM) on students' performance in Organic Chemistry.
2. There is no significant difference in the attitude of students towards learning of Organic Chemistry when HIT, ACIT, CCIT and CTM are used.

Procedure

The study adopted non-equivalent pretest-posttest control group research design. The population for the study comprised all Chemistry students in Senior Secondary School two (SSS II) in Osun State. The study sample consisted of 200 Chemistry students in their intact classes in four Senior Secondary Schools from four local government areas in Osun State. The sample was selected using multi-stage sampling technique. Four local government areas (LGAs) were selected from the existing 30 LGAs in the State using simple random sampling technique. One school was then selected from each LGA and one intact class of SS II students was selected in each school using simple random sampling technique as well. The four schools were randomly assigned to three experimental groups and one control.

Research Instruments

Two instruments were used for the study.

- i. Students' Chemistry Achievement Test (SCAT) consisted of 30-item multiple choice questions with four options A to D constructed to serve as pretest to ascertain equivalence of ability of subjects, posttest to determine the effect of the treatments on ability to solve problems in Organic Chemistry to ascertain if subjects retained the concepts taught. SCAT

for pretest and posttest contained the same test items.

ii Questionnaire on Attitude toward Chemistry (QAC)

This consists of two sections, A and B. Section A is students' biodata with respect to sex, age, name of school and class. Section B consisted of 25-items designed to find out the attitude of students toward the use of each instructional technique in learning Organic Chemistry. Subjects were required to respond to each item of the QAC on a five-point Likert-type scale, ranging from strongly agree to strongly disagree.

Data Collection

The experiment was carried out in six weeks. Research Assistants (Teachers) trained on the use of heuristic, associative creativity and community contact instructional techniques. Four lesson plans were prepared on weekly basis and used for the study. Each of the experimental groups and control were taught for double periods once in a week. The researcher prepared lesson plans on heuristic, associative creativity and community contact instructional techniques as well as conventional teaching method (control group).

In the HIT group, students conducted inquiry processes themselves while the teacher who served as facilitator presented specific problem and procedural operations on the topics. The aim of HIT was to encourage students to think on their own. In ACIT, students were given specific problem by the teacher and were then divided into a convenient number of small groups of five members (with at least one female) to work together. The aim of ACIT was to encourage students to make constructive suggestions rather than the teacher always spoon-feeding them with correct ideas in addition to persuading them to be inquisitive. In CCIT group, the teacher took students out of the classroom into the community to learn some concepts in Chemistry in order to see things in reality and for the process to become internalized in the minds of the students.

In CTM, the teacher asked the students questions so as to ascertain their previous knowledge before introducing the new topic, presents the lesson stage by stage making examples and illustrations verbally with reference and diagrams on a chart. He wrote on the chalk board, asked the students questions related to the topic to find out if the contents have been learned, wrote notes on the board for the students copy, summarized the key points verbally, briefly reflected the lesson, evaluated what is learned and then gave assignment to the learners.

Data Analysis

Data were analyzed using mean, t-test Analysis, One-way and Two-way Analysis of Variance (ANOVA) and One-way Analysis of Covariance (ANCOVA), and where significant difference existed the Tukey's post-hoc Multiple Comparison was used to determine the direction of the significance. In order to account for the possible difference among the groups, the pre-test and pre-attitude scores were used as covariates in ANCOVA. All the analyses were carried out at $p < 0.05$ level of significance.

Results

Hypothesis One

There is no significant effect of each of Heuristic Instructional Technique (HIT), Associative Creativity Instructional Technique (ACIT), Community Contact Instructional Technique (CCIT) and Conventional Teaching Method (CTM) on students' performance in Organic Chemistry.

In testing this hypothesis, the post-test scores of students in the experimental groups (HIT, ACIT and CCIT) and control group (CTM) were subjected to the Analysis of Covariance (ANCOVA) where pre-test scores were treated as covariates. The results of the analysis are presented in Table 1

Table 1: One way Analysis of Covariance (ANCOVA) of Post-test Scores of Organic Chemistry Students Exposed to HIT, ACIT, CCIT and CTM using Pre-test as Covariates

Source of Variance	Sum of Squares	df	Mean square	F	p
Corrected model	2733.20 ^a	4	683.30	38.37	0.00*
intercept	10026.55	1	10026.55	563.09	0.00*
Covariate	132.24	1	132.24	7.43	0.01*
Treatment	2594.55	3	864.85	48.57	0.00*
Error	3472.20	195	17.81		
Corrected Total	6205.40	199			
Total	82685.00	200			

*= significant at $p < 0.05$

Table 1 shows that there was a significant effect in the performance of students taught Organic Chemistry using HIT, ACIT, CCIT and CTM (control group) ($F = 48.57$; $p < 0.05$). The hypothesis was therefore rejected. This implies that there was significant effect of treatment on the performance of students taught Organic

Chemistry using HIT, ACIT, CCIT and CTM respectively.

To find the order of effectiveness of the treatments and direction of significance under investigation, the posttest scores were subjected to Post-hoc test. The result is presented in Table 2

Table 2: Post Hoc Multiple Comparison of Post Test Scores of HIT, ACIT, CCIT and CTM Groups

(I)	(J)	Means difference (I - J)	Std. Error	p
HIT($\bar{X} = 20.30$)	ACIT($\bar{X} = 20.86$)	-0.56	0.81	1.00
	CCIT($\bar{X} = 22.65$)	-2.35*	0.82	0.03*
	CTM($\bar{X} = 12.34$)	7.96*	0.89	0.00*
ACIT($\bar{X} = 20.86$)	HIT($\bar{X} = 20.30$)	0.56	0.81	1.00
	CCIT($\bar{X} = 22.65$)	-1.79	0.81	0.17
	CTM($\bar{X} = 12.34$)	8.51*	0.89	0.00*
CCIT($\bar{X} = 22.65$)	HIT($\bar{X} = 20.30$)	2.35*	0.82	0.03*
	ACIT($\bar{X} = 20.86$)	1.79	0.81	0.17
	CTM($\bar{X} = 12.34$)	10.31*	0.90	0.00*
CTM($\bar{X} = 12.34$)	HIT($\bar{X} = 20.30$)	-7.96*	0.89	0.00*
	ACIT($\bar{X} = 20.86$)	-8.52*	0.89	0.00*
	CCIT($\bar{X} = 22.65$)	-10.31*	0.90	0.00*

* = significant at $p < 0.05$

The result in Table 2 revealed that significant difference existed in HIT, ACIT, CCIT and CTM with mean difference as follows: CCIT & ACIT ($\bar{X} = 1.79$), CCIT & HIT ($\bar{X} = 2.35$) and CCIT & CTM ($\bar{X} = 10.31$) all in favour of CCIT; ACIT & HIT ($\bar{X} = 0.56$), ACIT & CTM ($\bar{X} = 8.51$) and HIT & CTM ($\bar{X} = 7.96$). The results also indicated that CCIT is the most effective technique ($\bar{X} = 22.65$), followed by ACIT ($\bar{X} = 20.85$), HIT ($\bar{X} = 20.85$) and CTM ($\bar{X} = 12.34$) in facilitating students' performance in Organic Chemistry.

Hypothesis Two

There is no significant difference in the attitude of students towards learning of Organic Chemistry when HIT, ACIT, CCIT and CTM are used.

In testing this hypothesis, the post-attitude scores of experimental groups (HIT, ACIT and CCIT) and control group (CTM) were subjected to the Analysis of Covariance (ANCOVA) where pre-attitude scores were treated as covariates. The results of the analysis are presented in Tables 3

Table 3: One way Analysis of Covariance (ANCOVA) of Post-attitude Scores of Organic Chemistry Students Exposed to HIT, ACIT, CCIT and CTM using Pre-attitude as Covariates

Source of Variation	sum of squares	df	Mean square	F	p
Corrected Model	22502.30 ^a	4	5625.58	11.67	0.00*
Intercept	62317.44	1	62317.44	129.25	0.00*
Pre-attitude	15.70	1	15.70	0.033	0.86
Treatment	22476.58	3	7492.19	15.54	0.00*
Error	94018.98	195	482.15		
Corrected Total	116521.28	199			
Total	186716.00	200			

* = significant at $p < 0.05$

Table 3 showed that there was a significant difference in the attitude of students taught Organic Chemistry using HIT, ACIT, CCIT and CTM (control group) ($F = 15.54$; $P < 0.05$). The hypothesis was therefore rejected. This implies that, the three experimental and control groups (HIT, ACIT, CCIT and CTM) differ significantly in

their enhancement of the attitude of Organic Chemistry students.

To find the order of effectiveness of the treatments and direction of significance under investigation, the post-attitude scores were subjected to Tukey's post-hoc test. The result is presented in table 4

Table 4: Post Hoc Multiple Comparison of Post Attitude Scores of HIT, ACIT, CCIT and CTM Groups

(I)	(J)	Means difference (I - J)	Std. Error	p
HIT($\bar{X} = 95.09$)	ACIT($\bar{X} = -3.30$)	-3.24	4.20	1.00
	CCIT($\bar{X} = -7.18$)	-7.15	4.27	0.58
	CTM($\bar{X} = 22.75$)	22.83*	4.67	0.00*
ACIT($\bar{X} = 98.39$)	HIT($\bar{X} = 3.30$)	3.24	4.20	1.00
	CCIT($\bar{X} = -3.88$)	-3.91	4.23	1.00
	CTM($\bar{X} = 26.05$)	26.07*	4.62	0.00*
CCIT($\bar{X} = 102.27$)	HIT($\bar{X} = 7.18$)	7.15	4.27	0.58
	ACIT($\bar{X} = 3.88$)	3.91	4.23	1.00
	CTM($\bar{X} = 29.93$)	29.98*	4.70	0.00*
CTM($\bar{X} = 72.34$)	HIT($\bar{X} = -22.75$)	-22.83*	0.89	0.00*
	ACIT($\bar{X} = -26.05$)	-26.07*	0.89	0.00*
	CCIT($\bar{X} = -29.93$)	-29.98*	0.90	0.00*

* = significant at $p < 0.05$

In Table 4, the result revealed that significant difference exists in HIT, ACIT, CCIT and CTM with mean difference as follows: CCIT & ACIT ($\bar{X} = 3.88$), CCIT & HIT ($\bar{X} = 7.18$) and CCIT & CTM ($\bar{X} = 29.93$) all in favour of CCIT; ACIT & HIT ($\bar{X} = 3.30$), ACIT & CTM ($\bar{X} = 26.05$) and HIT & CTM ($\bar{X} = 22.75$). The results also indicated that CCIT is the most effective technique ($\bar{X} = 102.27$), followed by ACIT ($\bar{X} = 98.39$), HIT ($\bar{X} = 95.09$) and CTM ($\bar{X} = 72.34$) in effecting better attitude in students towards Organic Chemistry.

Discussion

Effects of Heuristic, Associative Creativity, Community Contact and Conventional Teaching

Method on Students' Performance in Organic Chemistry.

The findings of this study revealed that all the four treatment groups: HIT, ACIT and CCIT were effective in enhancing students' comprehension and performance in Organic Chemistry. This may be due to the distinctive characteristics of the instructional techniques, being grounded in sound, cognitive and constructivist learning theories of Piaget (1970) and Bruner (1971) which centres on creative thinking and problem-solving skills. The findings further revealed that significant effect existed in students' performance when exposed to HIT, ACIT, CCIT and CTM.

Tukey's post hoc result also indicated that students in CCIT performed better than those in ACIT which in turn performed better than HIT with those in CTM being the least effective. This implies that CCIT enhanced students' performance more than other treatments. This agrees with the finding of Chang (2010) who concurred that integration of field trip was an effective learning mechanism that allows students to make the connections between field observations and more abstract concepts in Chemistry. It is also in tandem with Jackson and Leahy (2005) who found out that museum presentation contributed to students' personalization of material, thus, improved their performance.

Furthermore, Ajaja (2010) also established better performance of students exposed to Biology with field trip instructional technique compared to students exposed to conventional teaching method. Michie (1998) observed that field trip enhanced learning outcomes and the support of the school community. The finding is also in tandem with the work of Yusuf (2006) who observed that Community Contact Instructional Technique like field trip promoted learning by experience. The effectiveness of community contact instructional technique may be due to high level of students' participation in learning activities coupled with resource persons who taught them in their local language. All the students in the CCIT group saw things in reality and were able to relate concepts in Organic Chemistry to everyday life. Positive interdependence, dependence and self-reliance which are critical to successful application of Chemistry to society and the responsibility of use of scientific knowledge and evidence took place. CCIT benefits both weak and bright students. Weak students benefit from interaction with brighter students as well as the resource person, they learn the materials they are explaining in more depth and remember it longer (Johnson and Johnson, 1992). Through the use of community contact instructional technique, the Chinese's adage of "tell me and show me, I remember, and involve me I understand" that was made use of probably boosted the morale of learners, thereby promoting effort in the learning process. Hence the higher performance reported.

Attitudes of Learners toward Learning Organic Chemistry with HIT, ACIT, CCIT and CTM

From the results obtained, majority of the students under different treatments and control groups, showed positive attitude to the instructional techniques. Most of the students agreed that the instructional techniques are good for learning Organic Chemistry, as they enabled them to see the relationship between their observations outside the classroom and the scientific concepts learnt due to their relatedness to everyday life applications. The students were of the opinion that CCIT, ACIT and HIT provided them with better understanding of Organic Chemistry concepts. However, a significant difference existed in the attitudes of the three experimental groups. The CCIT group showed more positive attitude toward learning Organic Chemistry compared to the ACIT and HIT groups. These findings are consistent with the study of Ajaja (2010) who found a significant relationship between students' attitude and performance in Biology. It is also in tandem with Farmer, Knapp and Benton (2007) who found positive increase in students' attitude toward Biology and natural environment. Majority of the students who responded to the questionnaire (QAC) expressed that they would like to pursue science and technology in future because they found learning Organic Chemistry very interesting.

The different experimental groups used in this study called for students' participation inherent in group activities and construction of knowledge. This made the learning to be cooperative regardless of sex and academic ability level. This finding is in line with the United States national assessment of 4th and 8th grade civic education classroom which found that students' participation in group activities and projects tended to outscore those who rarely or never participated in this kind of classroom assignment (Adetunji, 2012). The outcome of this study is typical of the Child-Friendly School System (CFSS) initiative in Asia by UNICEF. The initiative draws on many of the principles of good practice that have been documented.

The instructional techniques used in this work have the following attributes among other:

- 1 inclusive, gender sensitive and non-discriminating,
- 2 encourage learners to think and decide for themselves, ask questions and express their opinions,
- 3 encourage learners to work together to solve problems and to achieve what they aim to do,
- 4 raise the students' motivation through presenting Organic Chemistry as a subject which is directly connected with both real life and the natural environment around them,
- 5 work up students' enthusiasm for activities that will ideally comprise all four spheres of the psyche: sensory and mental cognition, feelings and volition,
- 6 develop students' independence and self-reliance,
- 7 develop transferrable skills such as: observation skill, group and independent work and work management.

Conclusion

The study concludes that students' performance and attitude in Chemistry can be effectively improved using each of heuristic, associative creativity and community contact instructional techniques. However, the community contact instructional technique produced the best effect.

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