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The Efficacy of Jigsaw-Learning Model on Academic Performance of Polytechnic Students with Varied Learning Abilities in Kano, Nigeria

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ABSTRACT

The Efficacy of jigsaw-learning model on students' academic performance in chemistry at the polytechnic level in Nigeria has not been not been adequately investigated. This study therefore investigates such effect by comparing the academic performance of higher ability, average ability and low ability students exposed to the jigsaw-learning model and those exposed to the traditional method. Two groups of students were randomly selected for the study. One group was exposed to the Jigsaw-learning model of cooperative learning (experimental group) while the other group was exposed to the traditional method (Control group). Variable investigated was effect of the strategy on academic performance of high ability, average and low abilities students. The data generated was subjected to Scheffs' test of multiple comparisons at $P \leq 0.05$ level of significance. Result obtained revealed that:

- The use of jigsaw-learning model can be in tertiary institutes
- It has significant effect on the academic performance of students of all ability levels.
- It can be used to improve the performance of low abilities students
- It is a suitable method of teaching students of heterogeneous grouping.

This paper therefore recommends that chemistry teachers in polytechnics and other tertiary institutes need to have a clear understanding of the abilities level of their students to enable them tailor their teaching to meet the students' learning abilities and need of their students.

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Introduction

Science and technology have been recognized worldwide as the key factor of development. Therefore, the understanding of science is imperative (Abdullahi, 2010). He argued that the development of any society depends much on its scientific and technological achievements. Science and technology are critical factors of economic and social development, as it is through their application that the natural resources of the country could be transformed into goods and services for the better quality of life for the majority of the country's citizens. The economic development of a nation depends largely on the advancement of science and its application (technology). Science as a subject has gained prominence in the school curriculum and in the admission of policies in Nigeria tertiary institutions.

The importance attached to science had been trigged by the emphasis and increasing awareness of its roles, as enterprise in the development of any nation (Ahmad, 2013). The adaption of science in the national life marks the differences between development and underdevelopment and it is the basis of classification of countries into developed and underdeveloped nations (Bashir, 2005). To this end, the Federal Ministry of Education designed curriculum at the basic level as basic science while at the senior secondary level science subjects are treat as independent discipline of biology, chemistry and physics. These core science subjects are taken either as specialty or as basic requirement for certification of other courses at the tertiary level.

Chemistry is an important science subject in the Nigeria tertiary education curriculum. It is a core subject for the Medical Sciences, Textile Technology, Agricultural Science, Synthetic Industry, Printing Technology, Pharmaceutical Industries and Chemical Engineering (Jegede, 2010). As important as the subject is and in spite of the efforts of both the federal and state governments to encourage chemistry education, students still shun the subject (Bashir, 2005). He observed that many students have low self-efficacy in chemistry, they do not believe that they can study it and hence see it as a difficult subject to understand. This may be attributed to the abstract nature of the subject and the method used in teaching it (lecture method). Available evidences from the West African Examination Council, WAEC, (2011-2015) indicates that, the students' academic performance in chemistry, at the Senior Secondary Certificate Examination, SSCE, is worsens as years go by and many students changed courses in the universities and other tertiary institutions just to avoid chemistry. Yusuf (2015) was of the view that students generally have difficulty in understanding chemistry concepts. Perhaps,

this account for their consistent poor academic performance in subjects in the SSCE examination and this is demonstrates even in tertiary institutions.

In Kano State Polytechnic, a report from the Quality Control Committee (QCC 2015), showed that, the chemistry result has gradually worsened in the past five years. Table 1.1 showed the details of chemistry results for five consecutive years. This poor performance may be attributed to teaching method, which is lecture method as stated in the curriculum that the theoretical aspect of the course should be taught using lecture method. This poor academic performance resulted in low self-efficacy. Amini (2004), states that, the poor performance discourages students and lead to negative self-efficacy in the said subject. This persistence poor academic performance needs to be addressed in order to have a scientifically literate society. Technology and science development influence new opportunities in strategies and methods of teaching and learning of chemistry in particular and science subjects in general. Constructivism paradigm gives more opportunities to students for better understanding of the knowledge in a variety of perspectives and gives many possibilities. It is a learning approach that is centered on the learner, that is, it is student centered (Sahin, 2010). The expectation of this approach is that learning activities can be managed and directed independently by students (Ogawa, 2011) to achieve the learning goal (self-regulated learning).

Academic performance is one of the major variables in this study. It is defines as the measure of what a person has accomplished after exposure to educational progrmeded. Bashir (2015) opined that academic performance is the measure of what a person has accomplished after exposure to an educational progrmeded. He conducted a research on the effects of cooperative learning strategy and the essential benefits of cooperative approach. He showed that students who were exposed to the cooperative instructional method scored higher than those taught the same concept using the lecture method. Academic performance is commonly measures by examination, test or continuous assessment. This study investigates the effects of jigsaw-learning model on academic performance among National Diploma II (ND 2) students, with varied learning abilities.

Jigsaw-learning model is an instructional model developed by Aronson and Patnoes developed in 1997. It was based on the idea that, cooperation will develop each individual and each individual can reach his goal only if all reach theirs. Jigsaw-learning model, is a student-centered learning approach, the method has been documented throughout the literature as

effective in helping students obtain practical learning skills, abilities for effective communication and proficiency in terms of understanding knowledge, and it promotes academic performance (Slavin, 2011). The method essentially consists of breaking down a large topic into a number of small topics, with the production of an 'expert sheet' prepared by the teacher. The students work in a 'jigsaw group' which is heterogeneous in nature. They are assigned to read an expert sheet, and then those who have the same expert sheet move from the jigsaw group to a separate expert group in which they then discuss their topic in detail. Once the discussion in the new group is complete, they return to their jigsaw group, and teach all their jigsaw group members about the topic that they are now expert in. Finally, the groups are assessed, and individual grades are given. The ultimate aims of the jigsaw-learning model according to Ellio and Shapiro (1990) are as follows:

I. Improving learning through the active participation of students and interaction with one other.
II. Provide a suitable educational environment of appropriate action to support and promote team work and collaboration among students and increase internal motivation.
III. Provision of appropriate educational opportunities through which combination of mo dels and teaching methods are used.
IV. Promote respect for the opinions and views of others.
V. Use more thought processes and enhance creative thinking.
VI. Raising the level of academic performance and developed the self-efficacy of students in chemistry.
VII. Improve the retention level of learned concept.
VIII. Developing positive attitudes towards the education process, to feel comfortable and accept others.
IX. Increase in the collective communication between students and the strong sense of belonging to the group,
X. Accept their colleagues as a source of knowledge and information
XI. The provision of social communication and mechanisms to allow the exchange of ideas and ask questions freely.

xii The possibility of covering more information about the study subject

This study determined the efficacy of jigsaw-learning model among ND II students of varied learning abilities. There are various types of jigsaw-learning activities which are all modification of the original jigsaw i.e. jigsaw I which was developed by Elliot in 1978. There are four main types of jigsaw activities, namely jigsaw I, jigsaw II, jigsaw III and jigsaw IV. Aronson and Patnoe (1997), modified jigsaw I and come up with jigsaw II. They reported that Jigsaw II has two substantial changes: all students in the team read all the lessons, and the scores of students are combined to contribute to an overall team score. This method has been used for subjects in the social sciences, and in science particularly when the learning goals focus on concepts rather than skills (Slavin, 2000).

In the case of Jigsaw III, Steinbrink, Walkiewicz and Stahl (1995) modified Jigsaw II to increase the interaction between students. They noted that, Jigsaw III has the addition of a cooperative test review process. This cooperative test review involves reconvening the home group and reviewing the process. Finally, Jigsaw IV, developed by Bowen (2000), includes three important new features: an introduction, quizzes, and re-teaching after individual assessment. In order to stimulate students' interest in the lesson, the teacher first introduces the lesson by means of lectures, presentation of literature, questioning, proposing problems, or perhaps showing a movie in a 'plenary' class session. Students are then assigned to heterogeneous groups the jigsaw group and all students are assigned topics to read. Here each student discusses the expert sheet that is based on a list of all topics. Again, the students with the same expert sheet move to their expert group to discuss their topic. In order to check accuracy and understanding of students in the expert group, they are assessed by means of a quiz based on the expert sheet. The students return to their home group, teach themselves and take quizzes all based on the original material. The teacher reviews and clarifies any concepts which seem to be difficult to the students. The students take individual quizzes, and scores are combined to produce an overall team score. Finally, the teacher re-teaches any material which was misunderstood after the individual assessment process. Table 2.1 summarizes the main differences between Jigsaw I, Jigsaw II, Jigsaw III, and Jigsaw IV.

Table 1: Comparison of Jigsaw I, Jigsaw II, Jigsaw III, and Jigsaw IV (Salvin, 2000)

	Jigsaw I	Jigsaw II	Jigsaw III	Jigsaw IV
1	----------	----------	----------	Introduction
2	Expert sheet assign to expert groups	Same as jigsaw i	Same as jigsaw i	Same as jigsaw i
3	Members answer expert questions	Same as jigsaw 1	Same as jigsaw 1	Same as jigsaw 1
4	----------	----------	----------	Quiz
5	Members return to home groups	Same as jigsaw 1	Same as jigsaw 1	Same as jigsaw 1
6	----------	----------	----------	Quiz
7	----------	----------	Review process	Same as jigsaw III
8	Individual assessment and grade	Same as jigsaw II	Same as jigsaw II	Same as jigsaw II
9	----------	----------	----------	Re teaching

This study used jigsaw I to investigate its effectiveness on the academic performance, among students of polytechnic with different learning abilities in terms of academic performance. Jigsaw I is chosen because;

- It enables all students in the team to read all the lessons, such that there is interaction between the lesson and the students.
- The scores of students are combined to contribute to an overall team score. This will enable the researcher to look at all groups (Slavin, 2000).

Statement of the problem

Chemistry is a major course offers in the Department of Science Laboratory Technology in Nigerian Polytechnics. The analysis of chemistry results in the department of science laboratory technology of Kano State Polytechnic for five consecutive years (2010-2015) and the report from the Quality Assurance Committee (2013-2015) showed that the performance of students in chemistry is low (Bashir, 2005). This poor academic performance and difficulty in learning may be attributed to teachers' consistent use of lecture method. This method does not take into cognizance the learning abilities of students. Despite the immergence of new approaches to teaching like the jigsaw-learning model of cooperative learning, the problem-based approach, the inquiry method of teaching and many others, the approach to teaching remained unchanged as teachers insist on using the traditional method to teaching science (Ahmad, 2013). A summary of five consecutive years of organic chemistry results of Kano State Polytechnic, Department of Science Laboratory Technology is presented in Table 1.1:

Table 3: Statistics of ND II Students' Results in Chemistry (SLT 221) in Kano State Polytechnic from 2011 –2016

Year	Total number of students registered in the programmed	Total number of students that sat for the examination	Pass	% of pass	Failure	% failure
2010 -2011	224	222	96	43	28	57
2011 – 2012	261	255	87	34	168	66
2012 – 2013	231	221	112	51	109	49
2013- 2014	255	249	101	41	148	59
2014 – 2015	310	304	185	61	119	39

Source: Examination Office, Kano State Polytechnic (2016)

The statistics of students' performance in chemistry for five sessions as presented in Table 1.1 revealed that in 2010-2011 sessions, only 43% passed while 57% failed. In 2011-2012

sessions, only 34% passed and the remaining 66% failed. In 2012-2013 sessions, 51% passed while 49% spilled over the session. Similarly, in 2013-2014 sessions, 41% passed while 59% failed. The result in 2014-2015 sessions showed that only 61% passed and 39% failed. The results above showed the trend of performance for five consecutive years. This study used organic chemistry (SLT 221) to be the teaching subject, because it is activities-based. Table 1.1 showed the students success, failure in the subject, which is quite alarming. This study investigated the effect of jigsaw-learning model on academic performance of polytechnic students with varied learning abilities in North-west zone of Nigeria.

1.3 Objectives of the Study

This study has the following objectives:

1. To investigate the effects of the jigsaw-learning model on academic performance of students with varied learning abilities (higher ability, average ability and low ability) in the teaching of chemistry.

Research Questions:

1. Is there any difference in academic means scores of students with varied learning abilities taught chemistry concepts using jigsaw-learning model and their counterparts taught the same concepts using lecture method?

Null Hypotheses

Based on the research question stated above, the following null hypothesis was formulated for testing:

HO_1: There is no significance different in academic performance of students with varied learning abilities exposed to jigsaw-learning model and their counterparts exposed to lecture method.

Significance of the Study

The findings of this study would be useful to:

1. Lecturers in polytechnics and other tertiary institutions will find this research work useful because it will provide them with empirical evidence or otherwise for using jigsaw instructional strategy in tertiary institutions.

2. It will point a way of developing and enacting classroom practice to reflect a true science classroom and hope this would help students to re-think their perception of chemistry as a difficult subject and provides opportunities for the students to link the jigsaw classroom and real-world societal issues.

3. The study will help students in using the information learnt to solve actual chemical problems and transfer the knowledge and the skills acquired (to solve problems) in the different subjects' areas. This would consequently boost the understanding and achievement of students in science.

4. This study will be useful to educational planners, curriculum builders, and the regulatory bodies of tertiary educations, such as the National Board for Technical Education (NBET) the National Commission for Colleges of Education (NCCE) and the National University Commission (NUC). It may provide them with a guide with which they can understand the impact of using jigsaw instructional strategy and provide a bases at which they could enforce using it in teaching in tertiary institutions.

Methodology

Research Design adapted for the study was quasi-experimental, control group design, employing pre-test and post-test. The pre-test was conducted to determine the equivalence in academic performance between experimental and control groups. Post-test was administered after the treatment to determine to determine the effectiveness of the treatment. The experimental group received treatment using the Jigsaw-learning model, while the control group was taught using the lecture method. After treatment, the two groups were post tested to determine the effects of treatment.

Population, Sample and Sampling Procedure

The population of the study comprised of ND II chemistry students of the 6 State polytechnic in the North-west geopolitical region. Abdullahi Gusau Polytechnic Zamfara, Kano State Polytechnic, Hassan Usman Katsina Polytechnic, Husaini Adamu Polytechnic, Nuhu Bamalli Polytechnic Zariya and Kebbi State Polytechnic Zamfara. These schools were pretested using Chemistry Performance Test (CPT) and Self-efficacy Scale (SEQ). This was done to identify the two schools that can be used as experimental and control groups. The mean scores of the four schools in the chemistry Performance test (CPT) were tested using t-test statistic to choose a

pair of school that had no significant difference in their academic performance in the CPT. Kano State Polytechnic and Jigawa State Polytechnic were found to have no significant difference and were therefore selected. Kano State Polytechnic was randomly assigned experimental group and Jigawa State Polytechnic control group. In each of these two schools, the intact class was used so that the school academic calendar is not tampered with. The experimental group has a total population of 45 students, while the control group has 38 students. The total samples' size is 83

Instrumentation

Chemistry Performance Test (CPT) was used for the pretest and post-test, the instrument consists of forty item multiple choice questions developed by the researcher from accredited ND II question papers. It has a reliability coefficient of 0.76.

Results

To answer the research question the scores of students in different ability sub-groups was recorded and analyzed using non parametric statistic. The results are presented on Table 3.

Table 3: Mean, Standard deviation, and Means Difference of Students with Varied Learning Abilities in the Experimental and Control Group

Abilities grouping	N	Mean	S.D.	Means diff.
High ability experimental	11	37.00	2.75	
High ability control	10	32.00	3.80	5.00
Average ability experimental	22	34.22	6.32	
Average ability control	15	27.30	5.42	6.92
Low ability experimental	12	22.00	4.53	
Low ability control	13	17.52	5.37	4.48

Table 3 presents comparisons of the mean of various sub-group in the experimental and control groups. The high ability students in the experimental group had a means of 37 and standard deviation of 2.78 in contrast to the high ability students in the control group with means of 32 and standard deviation of 3.80. The mean difference of the two groups is 5. This indicates that there is difference in academic performance of high ability students in the experimental and control groups. Similarly, the average ability students in experimental group recorded a mean of 34.22 and standard deviation of 6.37, while average abilities students in the control group had a mean of 27.30 and standard deviation of 5.42 the mean difference is 6.95, which also indicates difference in the mean score of the two groups. The low ability students in the experimental group had means of 22 and standard deviation of 4.53 in contrast to control group with mean score of 17. 52 and standard deviation of 5.37 the means difference the two groups is 4.46 in favour of experimental group. The three comparisons shown in Table 3 indicate that there was remarkable mean difference between the experimental and control groups, in all the three cases the difference is in favour of experimental groups.

To test for significant differences the scores were further subjected to Scheffes' test of multiple comparisons and result is summarized in Table 4.

Considering high ability students in the experimental and control groups, the results from the Table 4.8b reveals that, p value at degree of freedom 19 is 0.021 which is less than 0.05. This indicates that there is significant difference between the performance of higher ability in the experimental and control groups in the favor of experimental group. Therefore, the null hypothesis is rejected.

Table 4: Scheffe Test of Multiple Comparisons on Academic Performance of Students with Varied Learning Abilities Exposed to Jigsaw-learning Model and their Counterparts Exposed to Lecture Method

Abilities grouping	N	Mean	S.D.	Df	P	Remark
High ability experimental	11	37.00	2.75			
				19	0.021	Sig
High ability control	10	32.00	3.80			
Average ability experimental	22	34.22	6.32			
				35	0.003	Sig
Average ability control	15	27.30	5.42			
Low ability experimental	12	22.00	4.53			
				23	0.001	Sig
Low ability control	13	17.52	5.37			

Significant at p <0.05

Also considering students in the average ability sub- groups in both the experimental and control groups the scores were subjected to Scheffe test of multiple comparisons Table 4 reveals that p (35) = 0.003; p < 0.05. i.e. p value at degree of freedom 35 is 0.003 which is less than 0.05 level of significant. This indicates that there is significant difference in academic performance of students in the average abilities sub-groups in the experimental and control groups in the favour of experimental group. Similarly, comparisons of low abilities results reveal that p (23) =0.001; < 0.05 i.e. p-value at degree of freedom 23 is 0.001 which is low level of significant. This indicated that there is significant difference in the performance of the two groups in the favour of experimental. From the three comparisons, the null hypothesis is rejected. There is significant difference in the academic performance of students with varied learning abilities exposed to jigsaw-learning model and their counterpart exposed to lecture method.

Discursion

The result reveals the effectiveness of Jigsaw-learning model in enhancing students' academic performance students irrespective of their abilities levels. This may be associated to the nature of Jigsaw-learning model that involves learning from one another, group discussion exchange of ideas respect for individual differences in the learning process. Higher abilities students have advantages over average and low abilities in their groups due to their higher order of thinking and their abilities to reason in abstraction and because organic chemistry concepts are abstract and require abstract thinking for that, they understand the subject matters quickly and easily. However, one of the requirements of jigsaw-learning model is that, group success is more important than the individual success for this reason the average and low abilities students are motivated and carried along (Anthony 2002). The higher abilities students are gaining more advantages in understanding the concepts in the process of explain the concepts to members of their jigsaw group (average & low abilities). The average and low abilities students have the following advantages: coming into close contact with the learning concepts, learning in small groups, learning from their friend freely and were motivated by the fact they are going to lead others in their home groups (Eilks, 2005).

The finding of this study agree to that of Lakpini (2006) how reported that activities base instruction enhance the academic performance of low abilities students, she argue that such methods bridge the gap between slow and average learners. Similarly, Baykara (2000) observed that slow learners to participate in activities based instruction and given them responsibilities in the learning (appointing them as group leader, or given them to lead a discussion) motivate them improve their learning outcome. Conclusively, Anthony (2009) reported that when students of chemistry are involved in the instructional processes, their academic performance is enhanced.

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